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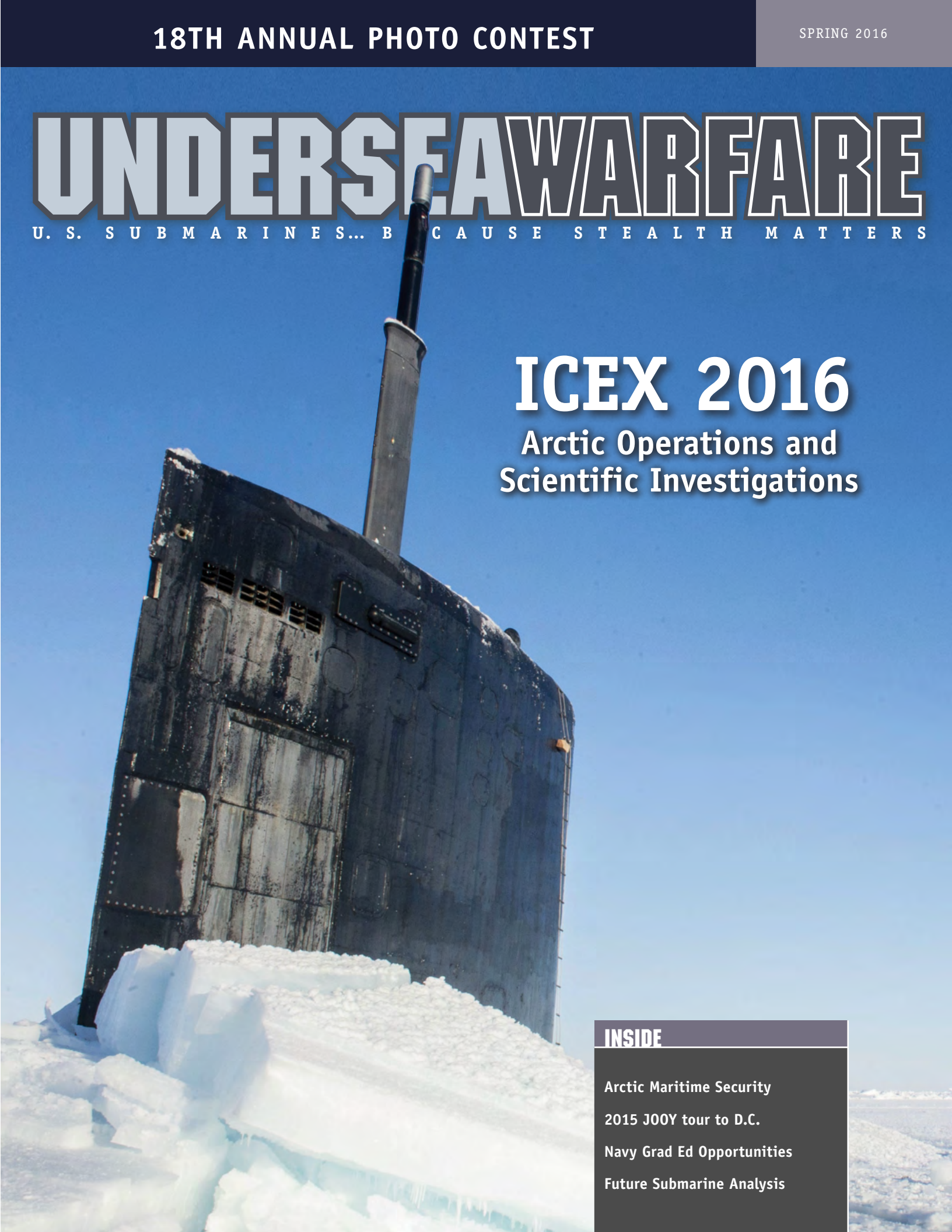

ICEX 2016

Arctic Operations and Scientific Investigations

INSIDE

Spring 2016
Issue No. 61

UNDERSEA WARFARE
THE OFFICIAL MAGAZINE OF THE U.S. SUBMARINE FORCE

ICEX 2016:
Arctic Operations and Scientific Investigations

On the Cover

USS *Hampton* (SSN 757) surfaces through the Arctic ice during Ice Exercise (ICEX) 2016.

Photo by MCS 2nd Class Tyler Thompson

Departments

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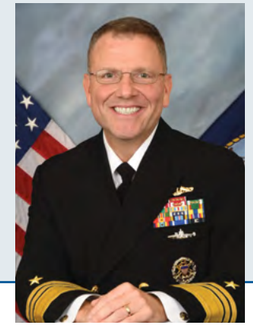
FORCE COMMANDER'S CORNER

Vice Adm. Joseph E. Tofalo, USN
Commander, Submarine Forces



Undersea Warriors,

Greetings from Norfolk! Last issue, I spoke about our history as a maritime nation, the challengers rising to contest our Navy's preeminence at sea, and our national commitment to maintaining our edge. In order to remain the finest Submarine Force on the planet and honor the trust that our nation has placed in us, every member of the Force and all its supporting organizations must continuously hone that edge. The saying, "If you're not getting better, you're getting worse," could not be more true today.

Our Force has historically enjoyed the advantage of a strong culture of continuous learning and innovation, but the pace of global change is getting faster. It is driven by the three interrelated forces of increased maritime traffic, the rise of the global information system, and an increasing rate of technological advancement and adoption. We need to get faster to outpace these global changes and our adversaries. We need to get faster across the board: in operations, learning, processes, acquisitions, and innovation. We need to get faster as individuals, teams, and organizations. And, like those who came before us, we must be bold but not reckless.

"We need to get faster to outpace these global changes and our adversaries. We need to get faster across the board: in operations, learning, processes, acquisitions, and innovation."

This issue is full of examples of the Force and supporting organizations getting faster. You'll read about Task Force 69's submarine operations in the Arctic Ocean, how we improve our ability to conduct those operations during Ice Exercise 2016, and how submarines themselves may change as we look ahead to the design of our next generation of submarines. That future submarine and other undersea initiatives may seem distant but, since last I wrote, we have successfully achieved several "firsts" as we mainstream autonomous undersea vehicles (AUVs) in the Submarine Force. We demonstrated the first successful launch of a commercial AUV from a submarine torpedo tube, to include the first successful AUV mooring to a system deployed from the same submarine. If that weren't enough, the crew of the host submarine also successfully commanded the AUV to rendezvous for high speed data exfiltration without the need to recover the AUV. Finally, we accomplished this in only two years. That may not sound like much if you are thinking about the speed of advancement in smartphones and tablets, but that's lightning quick in government acquisition. We achieved this by understanding the technology we were working with, using operational prototyping to rapidly test new ideas, always accepting the fact that innovation involves some failure, and being utterly committed to learning from any setbacks. Learning converts failure into new knowledge and improved performance.

The examples above highlight how we are getting faster as an organization. But this is not something we only do on headquarters staffs, in think tanks, or at design centers. Whether you are reading this on a submarine, in a shipyard, or in an office, wherever you are in the Submarine Force or its supporting organizations, you are the key to this process. No matter what you do, constantly look for ways to work better and smarter and share them with your peers, superiors, and subordinates.

That is how we all get better.

That is how we will win.

Thank you for all you do. Keep charging!

J.E. Tofalo

DIVISION DIRECTOR'S CORNER

Rear Adm. Charles A. Richard, USN
Director, Undersea Warfare Division

Undersea Warfare Team,

It's been an exciting first half of 2016, and I could not be more proud of what the Force has accomplished. The hard work of everyone who is directly or indirectly a part of the Undersea Enterprise is paying off. We are moving ahead and advancing the reach of our force around the globe.

In this issue we focus on operations in the Arctic. ICEX 2016 was a huge success that involved participants from four countries, from academia and scientists to several elements of the armed forces. There is a lot we still do not know about living and operating in the Arctic. ICEX 2016 advanced our understanding of this area of the globe, arguably one of the last frontiers. This year the USS *Hampton* (SSN 767) and USS *Hartford* (SSN 768) represented the Submarine Force during ICEX 2016. In addition, we tested UUVs and UAVs in the Arctic, tested a new type of ice-avoidance sonar, and supported extreme-cold-weather diving training just to name a few of the events conducted.

"What will the Submarine Force look like in 10, 20, or even 30 years? Collectively we are moving to a more netted navy, where the submarine will be a premier node in a system of systems in the undersea domain."

Many of you are aware that the Submarine Force doesn't only operate in the Arctic during the bi-annual ICEX. You will also see a snapshot of operations under CTF69's cognizance. It is important to realize all the organizations that support operations in the Arctic.

Vice Adm. Tofalo says "we must get faster." We are taking that direction to heart in DC to bring new tools and capabilities to everyone on the pointy end of the spear. From small UUVs to the newest *Virginia*-class submarine, we are working to adapt and master the acquisition process to deliver technologies faster.

As the Submarine Force resource sponsor, I spend a lot of my time thinking about the future. What will the Submarine Force look like in 10, 20, or even 30 years? Collectively we are moving to a more netted navy, where the submarine will be a premier node in a system of systems in the undersea domain. Submarine Force leadership and industry discussed this at this year's Submarine Technology Symposium. The time to start thinking about the next SSN is already upon us. I invite you to read about what's on my mind on that topic in this edition. The possibilities that the future holds for the next SSN are almost endless, and I encourage you to provide feedback and recommendations.

The people who make up our Submarine Force remain our most important commodity. We cannot accomplish all of this without your hard work. Thank you for your drive and dedication. Keep charging!

C. A. Richard

UNDERSEA WARFARE
The Official Magazine of the U.S. Submarine Force

Charter

UNDERSEA WARFARE is the professional magazine of the undersea warfare community. Its purpose is to educate its readers on undersea warfare missions and programs, with a particular focus on U.S. submarines. This journal will also draw upon the Submarine Force's rich historical legacy to instill a sense of pride and professionalism among community members and to enhance reader awareness of the increasing relevance of undersea warfare for our nation's defense.

The opinions and assertions herein are the personal views of the authors and do not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy.

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LETTERS TO THE EDITOR

In keeping with *UNDERSEA WARFARE* Magazine's charter as the Official Magazine of the U.S. Submarine Force, we welcome letters to the editor, questions relating to articles that have appeared in previous issues, and insights and "lessons learned" from the fleet.

UNDERSEA WARFARE Magazine reserves the right to edit submissions for length, clarity, and accuracy. All submissions become the property of *UNDERSEA WARFARE* Magazine and may be published in all media.

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FROM THE EDITOR

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See inside back cover for information on Naval Submarine League's 18th Annual Photo Contest

by Dr. Walter A. Berbrick

The Arctic Maritime Security Environment

For centuries, the remote and frozen latitudes of the Arctic have remained free from conflict, allowing nations to peacefully unlock new territory, trade routes, and resources in the maritime domain. The security environment is changing, however, and has the potential to challenge stability and economic development in the region. Climate change and technological advances combined with rising global demand for resources, increased military activity, and the historically intense relationship between the North Atlantic Treaty Organization (NATO) and Russia have intensified the potential for conflict over long-standing territorial disputes. In addition, non-traditional threats such as illegal fishing, terrorism, and other human and man-made disasters increasingly challenge the Arctic's future stability. The Arctic Ocean region is critically important to U.S. and European commerce, diplomacy, and security. Within the region are the three largest countries in the world—Russia, Canada, and the United States, the largest island in the world—Greenland, and over half of the world's coastline—Canada, Russia, Greenland/Denmark, Norway, and the United States. It contains the two largest militaries in the world—the United States and Russia, two nuclear-armed nations, and five of the 28 members of NATO.

Competing Territorial and Maritime Claims

The 1982 Law of the Sea Convention remains the bedrock of Arctic governance, but a few sovereignty disputes persist. The presence of new shipping lanes, large fish stocks, and extensive hydrocarbon and mineral deposits discovered, as well as the vast expanses yet to be explored, exacerbate these complex claims. A U.S. Geological Survey report estimates that the Arctic region alone accounts for nearly one-quarter of the earth's undiscovered recoverable petroleum, while more than 80 percent of these resources are thought to be offshore. No country has invested more in the Arctic than Russia, whose economy and federal budget rely heavily on hydrocarbons. According to a U.S. Department of Energy report, of the nearly 60 large oil and natural-gas fields discovered in the Arctic, there are 43 in Russia, 11 in Canada, six in Alaska, and one in Norway. The Arctic accounts for more than 10 percent of global fisheries production, with some projections surging to 40 percent over the next several decades as a result of changes in global fish migration.[1]

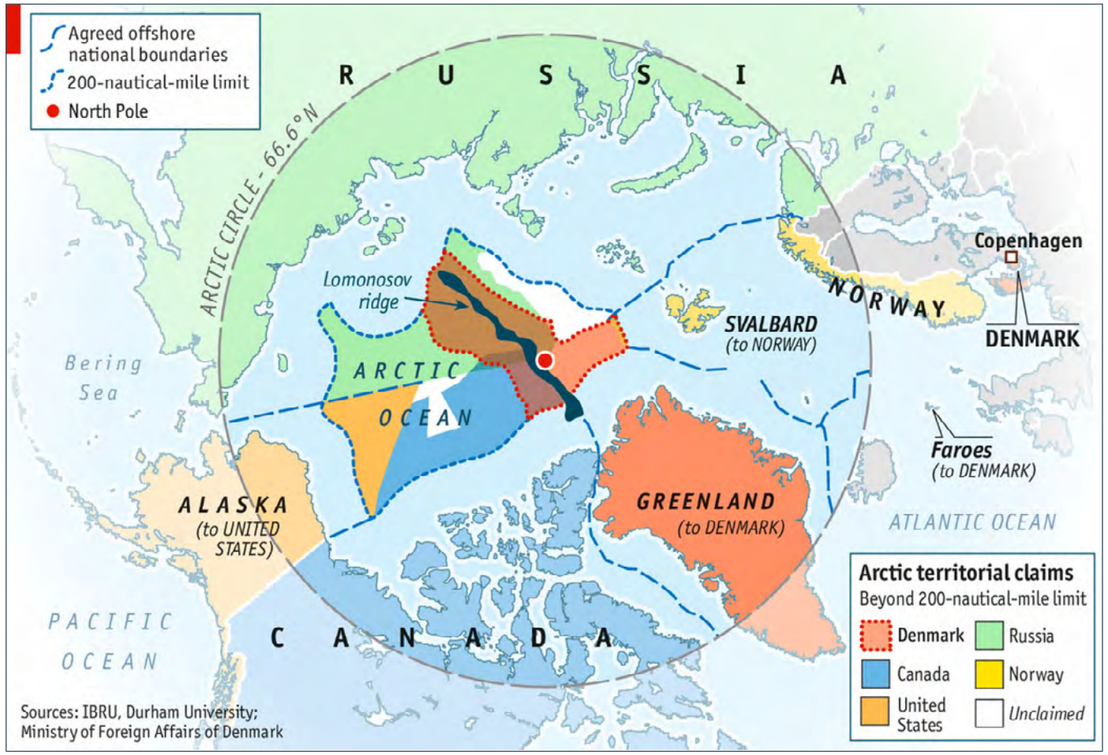
The Arctic Ocean region is an emerging pathway for global commerce and is essential for the region's anticipated economic growth. A voyage from Shanghai to Hamburg via the Northern Sea Route (NSR), a roughly 3,000-mile shipping lane across the top of Russia's coastline connecting the Atlantic to the Pacific, trims nearly 30 percent of the distance off a similar trip via the Suez Canal and avoids the heavily pirated Strait of Malacca and waters off the Horn of Africa. The Northwest Passage, running some nine hundred miles from Alaska through the Canadian Arctic Archipelago, cuts time and fuel costs off a traditional voyage through the Panama Canal, but shallow drafts and shorter shipping seasons make this route less commercially appealing than that of the NSR. In the meantime, the potential for conflict has been overshadowed by a number of positive trends in recent years, including new international forums and the peaceful resolution of maritime disputes in the region.

Extended Continental Shelves

There are competing claims among Russia, Demark, and Canada at the North Pole. The 1.1 million square miles of open water lying north of the five Arctic Exclusive Economic Zones (EEZs), is considered high seas and outside national jurisdictions. The UN Convention on the Law of the Sea permits Arctic coastal states to control all living and nonliving natural resources up to 350 nautical miles from the coast if the area proves to be a direct extension of the continental shelf. Over the last decade, Russia has conducted nine expeditions to the Arctic to map the ocean floor and validate its most recent territorial claim submitted last year, which includes the Mendeleev Rise as well as the Lomonosov Ridge, which Denmark and Canada also claim. A favorable adjudication of its claim would provide Russia access to an estimated 5 billion tons of hydrocarbons and extend its strategic and operational reach in the region. Denmark presented its claim to the UN last year, arguing that the 346,000 square mile area surrounding the North Pole—roughly 20 times the size of Denmark—is a natural extension to the continental shelf of Greenland. The United States takes no position on competing sovereignty claims in the central Arctic Ocean but encourages all three countries to maintain international law through the Law of the Sea Convention.

The Northern Sea Route and Northwest Passage

Regarding excessive maritime claims, several claimants within the region have asserted maritime claims along their coastlines and around land features that are inconsistent with international law. In the NSR, the situation is more complex. Russia, for example, has drawn coastal baselines (the lines from which the breadth of maritime entitlements are measured) claiming a series of marginal seas—the Kara Sea, the Laptev Sea, the East Siberian Sea, and the Chukchi Sea—which are linked by some 58 straits running through three archipelagos—the Novaya Zemlja, the Severnaya Zemlja, and the New Siberian Islands—as historical internal waters. Traditionally, Russia attempts to restrict foreign military activities within its EEZ and requires notification by foreign warships prior to exercising the right of innocent passage through its territorial sea. By the same token, the United States, the European Union, and other countries maintain that the



Northwest Passage is an international strait with free navigation rights, while Canada asserts that it is an inland waterway over which it maintains exclusive jurisdiction.

Russia and Canada use the 1982 UN Convention on the Law of the Sea, in particular article 234 "Ice-covered Areas" to regulate marine transportation, but Russian legislation extends beyond the prevention and monitoring of marine pollution from vessels in the areas covered with ice for most of the year. Although the United States encourages Russia's and Canada's efforts to align their maritime claims with the Law of the Sea Convention, Washington has not shifted position that these straits are international waters and subject to transit passage, which entitles foreign ships to pass through these straits without coastal state permission. U.S. diplomatic and military efforts have been sparse since Washington's failed attempt to sail the U.S. Coast Guard icebreaker Northwind through Vilkitsky Strait without Moscow's permission in 1965. Nevertheless, consistent with the long-standing U.S. Freedom of Navigation Policy, the United States encourages Russia and Canada to conform their maritime claims to international law and challenges excessive maritime claims through U.S. diplomatic protests and operational activities.

Beaufort Sea

Washington and Ottawa also disagree on their maritime boundary in the resource-rich Beaufort Sea, which dates back to an 1825 treaty between Great Britain and Russia, which owned Alaska at the time. Canada claims the Beaufort Sea runs due north following the land border between Yukon and Alaska's North Slope. The United States maintains that the sea border should go out at a 90-degree angle from the land. On a map, the resulting overlap in border claims resembles a pie-shaped, 8,100-square-mile area about the size of Lake Ontario. According to Canada's National Energy Board, the seabed below the disputed area contains approximately 2 billion cubic meters of gas—enough to supply Canada for 20 years—and over 1 billion cubic meters of oil. In March 2016, the Obama Administration announced plans for new oil and gas drilling leases in the Beaufort Sea, off the coast of Alaska, which would begin in 2020. However, Canada interpreted the action as provocative and "a violation of Canada's Arctic sovereignty."

Hans Island

There is one single disputed piece of land in the Arctic—Hans Island—a half-square-mile uninhabited island disputed between Canada and Denmark because of its position in the Kennedy Channel between Canada's Ellesmere Island and Denmark's Greenland. Currently, Canada and Denmark agree to disagree on who owns Hans Island. Plans to split the island have failed in the past, but under the terms of a 2005 agreement, both countries have agreed to inform the other before they visit. The militaries of both countries periodically visit to remove the other country's flag and leave a bottle of Danish schnapps or Canadian whisky.[2]

China

Emerging military and economic powers within sight are also competing for greater influence in the Arctic. India, Italy, Japan, Singapore, South Korea, and China became Arctic Council observer states in 2013. The Arctic Council, the leading international forum for cooperation in the region, develops policies and guidelines that focus on environmental protection and sustainable development but that exclude any cooperation on security and defense matters.[3] China's and India's interest in the region stems from rising energy demands, "new fishing grounds," and increased reliance on maritime trade.[4] Chinese officials now characterize their country as a "near-Arctic state," increasing its investment in polar research to $60 million annually while recently launching the PLA Navy's first Type-272 icebreaker.[5] China strengthened its position in the Arctic by signing a free trade agreement with Iceland in 2013, it's first with a European country, and building an embassy that is Reykjavik's largest.[6]

Russian Military Modernization and Strategic Intent

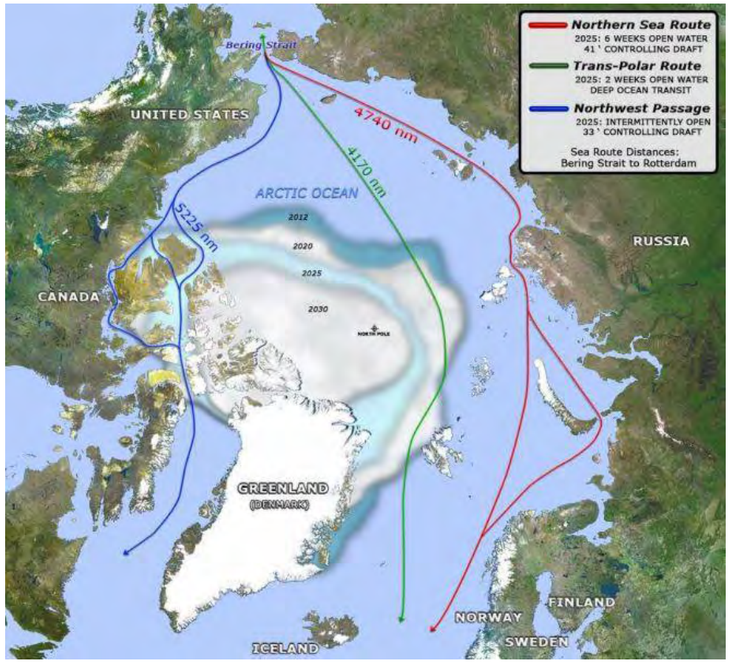
Over the last several years, all eight Arctic nations have updated their strategies for the region. Gradual military transformation across the Arctic region coupled with limited security engagement has increased the potential for tactical miscalculations in the maritime domain. Russia's strategic capabilities are significant. Russia, the only non-NATO littoral Arctic state, has made a military buildup in the Arctic a strategic priority, restoring Soviet-era airfields and ports, reorganizing naval assets, and increasing military operations and exercises in the region, including submarine patrols by 50 percent from 2013.[7] In 2015, Russia made the Arctic a central focus of its new maritime doctrine and established a new joint strategic command aimed at protecting Russian interests and countering NATO expansion in the region, even though the alliance remains internally divided on its future role in the region.[8]

Russia has plans to modernize nearly every aspect of its maritime-related military and law enforcement capabilities, including its ice breaking fleet, submarines, aircraft, missiles, radar capabilities, and border guard patrol. While quantity is only one part of its overall capability, over the last several years Russia launched more naval vessels than any other country in the Arctic. Russia's Northern Fleet, which now accounts for two-thirds of its Navy, possesses the most number of vessels in the Arctic with more than 100 surface ships, submarines, amphibious ships, and patrol craft. While Russia's actions are causing concern among neighbors in the region, there are several potential opportunities for collaboration.

Dispute Resolution

Despite a few remaining territorial disputes in the Arctic Ocean region, claimants have committed to peacefully settling disagreements. Notably, Russia and Norway resolved a decades-old maritime border dispute in 2010, equally dividing some 67,600 square miles of water in the Barents Sea. The historic deal is often cited as a model for future Arctic diplomacy. The very limited but growing number of bilateral and multinational exercises suggests Moscow's increased willingness to interact with partners. Participation in the Arctic Council and the recently formed Coast Guard Arctic Forum are encouraging signs of Russia's willingness to play an active and constructive role in regional affairs. In addition, the five states surrounding the central Arctic signed an interim agreement in 2015 to prevent unregulated commercial fishing in high seas portions of the central Arctic Ocean until a broader regulatory process is in place.[9]

The region's environment, history, cultural and political diversity, and robust military capabilities present dynamic strategic challenges. USEUCOM and USNORTHCOM share responsibility for enhancing U.S. force posture, presence, and resiliency in the region and modernizing U.S. force capability to ensure that forces are ready to respond to any contingency. Only together, working with allies and partners, will the capability and capacity of Europe and North America be enhanced to address threats in the emerging Arctic security environment.



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by Mr. Theo Goda

ICEX 2016

On a remote ice floe in the Beaufort Sea above the Arctic Circle, the U.S. Navy once again staged its remote ice camp to support Ice Exercise (ICEX), while below the ice two submarines maneuvered to avoid the obstacles of the ice canopy. ICEX is the Navy's biennial exercise used to validate and assess operational readiness of the Submtarine Force in the Arctic while continuing scientific research and military training in extreme cold conditions and in the undersea environment. During February and March 2016, the Navy's Undersea Warfighting Development Center (UWDC) Detachment Arctic Submarine Laboratory (ASL) led the coordination and operation of the Arctic ice camp located approximately 200 miles North of Prudhoe Bay, Alaska to support ICEX 2016.

ICEX 2016 included participation from USS *Hampton* (SSN 767) and USS *Hartford* (SSN 768), along with over 30 organizations and 200 personnel from the United States, Canada, Great Britain, and Norway. These personnel represented experts in submarine operations, the austere Arctic environment, and a multitude of scientific and military fields.

Ice Camp SARGO

After months of analysis and two days of reconnaissance and pioneering efforts to identify an ice floe suitable for the ice camp, construction began by a team of ICEX personnel from ASL, Sailors from Submarine Squadron 11 (SUBRON 11), and engineers from the University of Washington's Applied Physics Laboratory (UW/APL). The ice camp was named Sargo to honor the crew of USS *Sargo* (SSN 583), which conducted the first submerged winter transit of the Bering Strait in 1960.

Initially Ice Camp SARGO was located 185 nautical miles (nm) north-northeast of Prudhoe Bay, which was the staging location to support it. Over the course of the exercise, the camp drifted over 150 nm westward in the Beaufort Sea.

The ice camp was established to provide the means to assess submarine readiness and provide temporary systems for undersea communications and submarine navigation relative to the shifting ice floe. The camp also presents an opportunity to host scientific research and training specific to the Arctic region, so experts from these communities added to the camp's presence. The camp consisted of multiple berthing shelters, a galley and mess tent, a tent for safety watchstanders and project work, the tracking range tent, a tent for diving and undersea vehicle operations, a tent for equipment maintenance, a command center, and multiple ice runways.

Airlift over Ice Camp SARGO

The ice camp was supplied with equipment and materiel through two means; the primary means was by small aircraft from Prudhoe Bay, and the secondary means was through an airdrop facilitated by Alaskan Command (ALCOM). The single airdrop consisted of over 12,000 pounds of shelters and equipment dropped by a C-17 aircraft. This marked the first time that ice camp construction materials were delivered via airdrop, and it significantly reduced the delivery and set-up time.

After ICEX 2014, the Navy decided to shift its ice camp model to support reusability of shelters, reduce environmental impact, and reduce the time required to construct the camp. With this new model, it would be able to continue submarine testing and assessment while expanding opportunities for scientific research and training for government and military organizations.

While the airdrop helped reduce construction time for the ice camp, the ICEX team decided to replace the traditional wooden shelters with conventional pole tents and airbeam tents. ASL collaborated with the Army's Natick Soldier Research, Development & Engineering Center (NSRDEC) on shelter and heating capabilities for the ice camp and decided to implement several airbeam tents. NSRDEC provided multiple airbeam shelters and forced air heaters that were tested for berthing, watch standing, and to support training and RDT&E projects.

The airbeam tents and forced air heaters performed well in conditions exceeding -20°F, -45°F wind chill, and 25-knot wind gusts. Due to the rapid set-up of the airbeam tent, a small portion of the ICEX team was able to spend the night on the ice from the first day they were set up, a first for the ICEX Program.

The ICEX team also implemented multiple flooring and heating systems for the shelters to evaluate the performance of each type of material and improve the construction in future ice camps. This included flooring systems with conventional wood designs, composite material, and various foam insulation systems with capability to install directly on the ice or with an elevated platform. The testing of these systems will be used to ensure adequate insulation properties while reducing the time to construct the floors and reduce weight.

The ICEX team installed and tested two systems that may reduce fuel consumption on the ice: a wind-powered turbine and a solar power system. These two systems were implemented and used to power the command center for several hours each day. This initial proof of concept was deemed successful and may be expanded in future ice camps.

Ice Camp SARGO Participants

Arctic experience and expertise, especially on the sea ice, is unique and difficult to amass. The Navy recognized that it needed to continue gathering this experience and train active duty military personnel to operate in this environment. As such, the Sailors from SUBRON 11 played a significantly larger role in this ICEX. These Sailors trained with ASL for five months prior to the ice camp so that they were ready to support construction and demobilization of the ice camp, act as watchstanders to ensure safety of project operations, mine ice to produce water, assist in remote field parties as polar bear lookouts, and assist in the loading of planes with cargo for the camp and its training and research projects. These Sailors augmented the ASL and UW/APL personnel on the ICEX team and were fundamental to the success of ICEX. The combination of the airdrop, airbeam structures, and increased number of ICEX personnel (including the SUBRON 11 Sailors) allowed the ice camp to start hosting participants overnight on the fifth day of the build. Ice Camp SARGO was fully operational in eight days, a significant reduction from the historical average ice camp buildup of two weeks.

International participation in ICEX continued in 2016 with Canada, Great Britain, and for the first time, Norway. The Norwegian Defense Research Establishment sent an observer to the ice camp to collaborate with experts in Arctic operations and autonomous undersea vehicle technologies.

The Royal Canadian Navy continued support of ICEX by participating as camp safety watches and range safety officers, which track and communicate with the submarines during testing evolutions. The Royal Canadian Air Force's 440th Transport Squadron also participated in the ICEX by flying personnel and cargo to the camp with a Twin Otter aircraft. This added level of participation was extremely valuable for the exercise as it allowed flexibility to its transportation services and increased payload to get materiel and equipment on and off the ice.

Great Britain's Royal Navy also continued its long history of participation in ICEX with camp safety watches and range safety officers. In addition, the Royal Navy also embarked multiple personnel aboard USS *Hartford* and USS *Hampton* to observe under-ice navigation and Arctic operations.

In addition to supplying materiel and equipment for the ice camp construction via the airdrop, ALCOM and its supporting commands also conducted an exercise within ICEX to evaluate its Arctic Sustainment Package and validate its Long Range Search and Rescue (LSAR) capabilities in the Arctic ice environment. This exercise marked the farthest north that the Alaska Air National Guard's LSAR capability was tested. As part of the exercise, 10 personnel from the Air National Guard's 212th Rescue Squadron and two personnel from the Alaska Army National Guard parachuted onto the ice next to the ice camp. The 212th Rescue Squadron established its emergency shelters adjacent to the camp to demonstrate that it is capable of supporting rescue operations on the Arctic ice. The exercise also included Alaska Army National Guard participation to airlift the personnel and equipment off the ice with helicopters along with the Alaska

Members of SUBRON 11 gather for a quick photo at Ice Camp SARGO.

The Arctic Environment

Whether one looks at the Arctic Ocean from a military, geographic, or scientific perspective, it is truly unique. The Arctic remains the most poorly understood ocean environment on earth. The physical features that make it different also make it difficult to study and understand. A few facts will illustrate the distinctive nature of the Arctic Ocean.

Although the Arctic is only 3.6% of the total area of the world's oceans, it contains 25% of the world's continental shelf area, generally defined as water less than 100 fathoms (600 feet) deep. The Arctic Ocean also receives 10% of the world's total fresh water river runoff. The combination of these factors causes Arctic Ocean salinity and density to vary dramatically. When ice cover is present, the mechanisms that would normally mix this fresh water with the ocean and the atmosphere—wave action, wind, and evaporation—cannot take place. Therefore, the lighter, fresher water forms a thick, low-density layer atop the ocean water. Because of the cold atmospheric temperatures, the ocean beneath the ice is coldest at the surface and warms at deeper depths, the inverse of more temperate oceans.

Both the Atlantic and the Pacific Oceans provide input to the Arctic. The water arriving in the Arctic from the Pacific must pass across hundreds of miles of the shallow Bering Strait region, so it is very cold and extremely rich in nutrients. On the other hand, Atlantic water enters the Arctic mainly through the deep Greenland Sea. As a result, this water has fewer nutrients and is much warmer. Thus, the overall heat budget of the Arctic Ocean is driven not just by atmospheric temperatures and ice cover, but also by the balance between Atlantic and Pacific waters in the deep Arctic Basin. Data collected since the early 1990s (primarily by submarine launch of expendable oceanographic devices) indicate that this balance had swung in favor of the Atlantic waters, resulting in an overall warming of the Arctic Ocean.

And, of course, there is the ice itself. There are actually two kinds of ice in the Arctic.

Icebergs are chunks of glaciers that have broken free ("calved") and are floating on the ocean. These are composed of fresh-water ice that originated on land. The primary sources of icebergs are the ice caps that overlie Antarctica and Greenland.

The more prevalent kind of ice is seawater that has frozen into ice pack. This covers the majority of the Arctic Ocean and its peripheral seas in winter, receding to about 70% of its maximum extent in summer. If left undisturbed, it may vary in thickness between a fraction of an inch to 10 or 12 feet. When winds and currents cause interaction between different sections (floes) of ice, it is distorted into ridges, which extend above sea level, and corresponding keels, which extend below. The deepest ice keel observed to date was 189 feet deep. This was in the Lincoln Sea where ocean currents pile the ice against the north coasts of Greenland and Canada.

Air National Guard. This exercise was also very informative for the Navy, and ASL will continue to collaborate with ALCOM on enhancing the ICEX Program.

The Naval Postgraduate School (NPS) sent multiple teams to ICEX to conduct research, development, testing and evaluation of the performance of extreme cold weather systems in the Arctic environment. NPS conducted research and development to include hydrographic measurements, signal propagation, ocean profile measurements, and Expendable Mobile Anti-Submarine Warfare Training Target (EMATT) employment in the Arctic. NPS also conducted unmanned undersea vehicle (UUV) test and evaluation through mapping of under-ice topography and testing UUV ability to navigate under shifting ice floes. NPS was also able to conduct unmanned aerial vehicle (UAV) testing and evaluation in extreme cold weather conditions. The NPS UAVs were also used to support the exercise by evaluating ice floe conditions and submarine surfacing events.

Royal Canadian Navy divers holding USS *Sargo* flag

The Naval Research Laboratory (NRL) conducted scientific research to further knowledge of Arctic ice and improve remote ice thickness measurements during ICEX. They also supported the ice floe selection for the ice camp through reconnaissance flights with radar and LIDAR (light detection and ranging) capabilities to analyze ice and snow characteristics.

The Massachusetts Institute of Technology conducted Autonomous Undersea Vehicle (AUV) testing and evaluation of a towed hydrophone array and assessed changing environmental acoustics of the Arctic.

In addition to implementing the ice suspended tracking range and tracking submarines and AUVs/UUVs, UW/APL also tested a wireless remote tracking range (RTR) system, enabled underwater voice communications with submarines, deployed an ocean/ice buoy, and as the prime logistics contractor they managed fuel, aircraft, waste, food services, and hangar contracts. UW/APL also supported the ice camp build alongside Navy personnel, provided expert guidance on the ice floe selection, and supported other ICEX project participants.

Multiple organizations conducted extreme cold weather diving training, tested new diving equipment, operated remote operating vehicles, and assisted in AUV recovery. This included Royal Canadian Navy Fleet Diving Unit (Pacific), Mobile Diving and Salvage Unit Two, SEAL Delivery Vehicle Team 1, and the U.S. Coast Guard Regional Dive Locker West.

In addition to supplying tents and heaters for the ice camp, NSRDEC also tested prototype tents and legacy tents. They evaluated the operational form, fit, function, set-up, and fabric performance of the tents in extreme cold weather.

The Naval Meteorology and Oceantography Command deployed meteorological sensors and stations and provided weather observations and forecasts for the exercise. The meteorological data gathered at Ice Camp SARGO will be used to enhance forecast modeling in the Arctic.

The Naval Undersea Warfare Center (NUWC) implemented a Digital Acoustic Communications System and provided text-based communications between the camp and the submarines.

Submarines

"Submarine operations as part of ICEX provide the necessary training to maintain a working knowledge of an extremely challenging region that is very different than any other ocean in the world," said Cmdr. Scott Luers, officer-in-tactical-command and deputy director of operations for Commander Submarine Forces in Norfolk. "Navigating, communicating, and maneuvering are all different in an Arctic environment as there are surfaces both above and below a submarine."

ASL Arctic Operations Specialists embarked on both submarines for the duration of their underways to provide guidance to the boats on how to interpret the Arctic systems and how to operate safely under the ice canopy.

USS *Hampton* participated in ICEX as part of its change of homeport from San Diego to Portsmouth Naval Shipyard. The crew transited the Bering Strait in the winter, a precarious operation due to shallow water and ice coverage, and spent a total of 36 days under the ice pack. The *Hampton*'s crew conducted seven vertical surfacing events through the ice pack as part of ICEX.

USS *Hartford*, homeport in Groton, Conn., conducted Arctic operations under the ice pack for 30 days and conducted eight vertical surfacing events. The boat was able to conduct an evaluation of a new variant of ice avoidance sonar during ICEX.

Both submarines participated in tactical development exercises at ICEX. They were able to communicate with the ice camp, which was operating a remote tracking range for the exercise. Testing also included investigation of sound propagation, the results of which will be used to update submarine tactics for the Arctic.

"ICEX 2016 is our continued commitment to the development of undersea warfare capabilities and tactics in all areas of the world," said Rear Adm. Jeff Trussler, Commander, Undersea Warfighting Development Center.

North Pole

ICEX 2016 included two North Pole excursions by the participating submarines. The Secretary of the Navy, Ray Mabus, embarked aboard USS *Hampton* at Ice Camp SARGO for the trek to the North Pole. He arrived at the North Pole on March 19th, 2016 and departed the following day to return to camp. This marked the first time that a Secretary of the Navy visited the North Pole. The Submariners on *Hampton* were grateful for the underway time with the Secretary, as they were able to demonstrate their expertise, share their knowledge of the Arctic and submarine operations, and receive strategic insights straight from the top.

Hampton and *Hartford* rendezvoused at the North Pole on March 30th, 2016. This was the first joint-surfacing event of U.S. submarines at the North Pole since 1990. The submarines surfaced through four feet of ice and had the opportunity to enjoy a little


A UH-60 Black Hawk Helicopter, assigned to the 1-207th Aviation Regiment, Alaska Army Air National Guard, flies over USS *Hampton* (SSN 757) during Ice Exercise (ICEX) 2016.

Impact of the Arctic on Submarine Operations

Experienced Arctic travelers know that nothing ever works the same in the Arctic as in warmer climates. This is also true for submarines. Because of the cold temperatures and the presence of ice, anything the submarine has or does that interfaces with the environment works or is performed differently in the Arctic.

One major impact on submarines is the lower-density water. To maintain neutral buoyancy in these conditions, a submarine must be able to match the lower density of the surrounding water. The need to operate in the Arctic sets one of the bounds on how much weight can be designed into a submarine.

The cold temperatures also impact the engineering of our submarines. Since normal shallow Arctic Ocean temperatures are about 29°F, no piping containing fresh water, which freezes at 32°F, may come in contact with the ocean. Submarines also use seawater systems to remove heat from the ship's atmosphere, engineering plant, and auxiliary systems. Since the frigid Arctic's water is much more efficient at removing heat than the water in more temperate oceans, our submarines must be engineered to adapt to these differences.

While some of these factors are addressed in the design of our submarines, other factors can only be addressed by adapting the way in which our submarines are operated.

The most significant of these changes come about in response to the ice, seen by the submarine as an ice canopy. Whenever a submarine is operating at a shallow depth, whether by choice or if forced to by being in shallow water, its crew must be constantly vigilant to avoid ice keels. This is done using high frequency Ice Keel Avoidance (IKA) sonar, which is capable of detecting hazards at sufficiently long range to permit the submarine an opportunity to make avoiding maneuvers.

In normal conditions, if a submarine needs to update its location from a navigation (GPS) satellite, transmit a message, or grab a gulp of fresh air, it simply drives up to periscope depth. Going to periscope depth is also the immediate response to most submarine casualties. Submarines cannot do this when operating beneath the ice. Instead, they must either ascend through small areas of open water or find a large, thin, flat ice feature, hover beneath it, and break through the ice vertically using its strengthened sail. This through-ice surfacing requires a number of special preparations.

- The submarine's sail and topside superstructure must be designed to withstand the impact and loading of the ice.
- Prior to venturing to the Arctic, crews must practice the surfacing evolution until perfected.
- The Arctic Submarine Laboratory installs extra sensors aboard these submarines to assist in detecting, mapping, and monitoring surfaceable features.

Because of the unique salinity layers in the Arctic, sonars perform differently here than in other oceans. There is a tendency for sound to bend upward where it is scattered, weakened, and distorted by the irregular ice overhead. Submariners need to understand these differences in order to get the most out of our sonars and torpedoes.

The way that Submariners (along with mariners, aviators, and researchers) normally monitor the ocean environment is to expend probes that provide a vertical temperature profile. Under standard ocean salinity conditions, this temperature profile may be converted easily into a sound speed profile (SSP). Here again, normal procedures must be adapted because the Arctic has highly variable salinities. For this reason, submarines deploying to the Arctic must carry special probes that measure sound speed more precisely and are designed to avoid impact with the ice.


A Deep Ice Keel captured by a SRVS Camera

liberty. The ships conducted re-enlistment ceremonies, dolphin presentations, and the two crews were able to interact and share their Arctic experiences.

Science Ice Exercise

During ICEX 2016, *Hampton* and *Hartford* collected water samples and data in support of Science Ice Exercise (SCICEX) Science Accommodation Missions (SAMs).

Submarine collection of SCICEX data, specifically between 1993 and 1999, has been credited for providing fundamental information that helped scientists recognize and validate that the Earth's climate was changing. These missions continue to collect data to advance the scientific community's knowledge of ocean hydrography, biology, chemistry, and sea ice profiling in the region.

Sea ice profiling data were collected from upward-facing sonar; bathymetry was recorded by fathometers; and salinity, conductivity, temperature, and depth were recorded through boat-installed sensors and probes. Water samples were also collected for biological and chemical analysis.

Distinguished Visitors

With the increasing interest in the Arctic region, ICEX presents an intimate opportunity for strategic decision makers to gain hands-on and personal experience that would not otherwise be possible. Ice Camp SARGO, *Hampton*, and *Hartford* all hosted distinguished visitors during the excercise.

Adm. James Caldwell, director, Naval Nuclear Propulsion Program, hosted a group at Ice Camp SARGO and on an overnight embark aboard *Hartford* to include Sen. Chris Murphy (CT), Sen. Roger Wicker (MI), Rep. Derek Kilmer (WA), Rep. Jim Cooper (TN), Rep. Steve Womack (AR), and Rep. Mac Thornberry (TX).

Hartford also hosted Lt. Gen. Russell Handy, Commander, Alaskan Command, U.S. Northern Command, for an overnight embarkation.

In addition to hosting the Secretary of the Navy for the North Pole expedition, *Hampton* also supported a media embark to demonstrate its Arctic capabilities.

The Commander of the Royal Canadian Navy, Vice Adm. Mark Norman, was hosted by the Commander, Submarine Force, U.S. Pacific Fleet, Rear Adm. Fritz Roegge for an overnight at Ice Camp SARGO.

Rear Adm. William McQuilkin, Director, Navy Strategy and Policy Division (OPNAV N51) hosted a U.S. Arctic Council delegation led by Special Advisor to Secretary of State on Arctic Science and Policy, Hon. Fran Ulmer and US Senior Arctic Official, Julia Gourley at Ice Camp SARGO.

The Commander Naval Meteorology and Oceanography Command and Oceanographer and Navigator of the Navy, Rear Adm. Timothy Gallaudet was hosted at the ice camp by the Commander, Undersea Warfighting Development Center, Rear Adm. Jeff Trussler.

U.S. Submarine Arctic Capabilities

Breakthrough Capability. All classes are capable of breaking through some amount of ice.

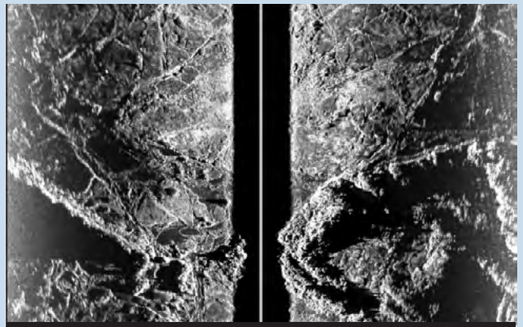
- The *Los Angeles*-class (688) is the most restricted because of its sail planes. Unlike earlier classes, 688s cannot rotate their sail planes to the full vertical position. As a result, this class is limited to less than about 1.5 feet of ice breakthrough.
- Both the Improved *Los Angeles*-class (688I) and *Seawolf*-class have bow-mounted planes, which eliminates this concern. They were designed to surface through at least three feet of ice and have repeatedly demonstrated this capability.
- The *Virginia*-class (774) was designed to have similar breakthrough capability to the original 688s. Although it is estimated that 774s could surface through at least 3 feet of ice, the Navy limits them to surfacing through open water or slush because of fragile systems mounted atop their sails.

Ice Keel Avoidance (IKA) Sonars. All of our SSNs are equipped with high frequency sonars capable of detecting ice hazards protruding down into the water column.

Submarine Remote Video System (SRVS). This is a low-light-capable underwater camera mounted flush with the top of the submarine's sail that provides a view of the underside of the ice canopy. Relying entirely on natural sunlight, this camera allows the submarine to evaluate ice features and monitor its movement when preparing to surface. It also shows cracks in the ice, variations in the snow cover, footprints, and marks left in the snow by camp personnel.

Environmental Conductivity, Temperature, and Depth (CTD) Sensor. From measuring conductivity, temperature, and depth, this system's computer can calculate other essential data such as the speed of sound, which is needed for making sonar performance estimates, and density, which is needed to track the severe density gradients encountered in the Arctic Ocean, especially when surfacing through the upper low-salinity stratum. In addition to the CTD Sensor's usefulness to the submarine operators, its data are also provided to the scientific community to assist in monitoring changes in the Arctic waters.

Side-Scan Sonar System. The Arctic Submarine Laboratory uses commercial side-scan systems and, after ice hardening, installs them on the sides of submarine sails. Pointed upward, these give a picture-like record of the underside of the ice canopy in a swath about a mile wide. The resulting image is similar to close-up pictures of the moon's surface. This tool is the primary means by which submarines search for thin-ice features that they can surface through.



The underside of the Arctic pack ice, as seen by the Side Scan Sonar

Secretary of the Navy, Ray Mabus in photo below and Rear Adm. Fritz Roegge, commander, Submarine Forces Pacific pictured at right were just two of the VIP's that participated in ICEX 2016.

At right, Rear Adm. Fritz Roegge, Vice Adm. Mark Norman, Commander, Royal Canadian Navy, greet Larry Estrada, director Arctic Submarine Lab.

The Arctic Giveth and Taketh

It is inevitable. The ice will eventually fracture. There is no way to prevent it. A group of experts from multiple academic, scientific, and military organizations spent months analyzing satellite imagery of ice floes, weather patterns, and logistic capabilities to select an ice floe suitable to serve as the hosting site for the ice camp. The objective was to select an ice floe that would remain within the vicinity of Prudhoe Bay long enough to build the camp, conduct scientific research and military training, and disassemble the ice camp while ensuring environmental compliance. This time period was estimated at five weeks.

On the evening of March 23rd, 2016, 21 days into the exercise, a fracture in the ice developed in the midst of the ice camp. While the ICEX team had overcome previous ice fractures in the vicinity of the ice camp, this fracture was too severe to surmount. Fortunately, the Navy had already met all of its primary objectives. The following morning the ice camp commenced full-scale demobilization of all personnel.

Over the course of the next week, ICEX personnel were flown daily to the ice camp to disassemble and remove materiel and equipment from the ice.

The ICEX team disassembled Ice Camp SARGO infrastructure and manually loaded an estimated 66,000 pounds of materiel and equipment into two aircraft over the course of seven days for its return trip to Prudhoe Bay. This work was accomplished in brutal conditions with temperatures exceeding -20°F, wind chill below -40°F, with little or no heat on the ice, and flying three hours a day to and from the camp.

The extensive preparation and grueling execution of ICEX 2016, to include Ice Camp SARGO and submarine involvement, was worth the effort. "The objectives of demonstrating presence, gaining additional Arctic operational experience, furthering partnerships, and expanding scientific research were all achieved over the four weeks in which the ice camp was operational. The hard work and dedication displayed by the Arctic Submarine Laboratory, the ICEX participants, and the shore support team made this event an overall success," said Vice Adm. Joseph E. Tofalo, commander, Submarine Forces.

For historical information on the Arctic Submarine Laboratory, the Navy's involvement in the Arctic, and ICEX 2016 pictures and video, you can visit the following websites.

www.facebook.com/arcticsublab/

www.public.navy.mil/subfor/uwdc/asl/

www.dvidshub.net/feature/ICEX2016

Mr. Theo Goda is a prior submarine officer and the current Ice Exercise (ICEX) Program Manager for the Arctic Submarine Laboratory.

by Sean Lastuka and Dr. Heather Havens

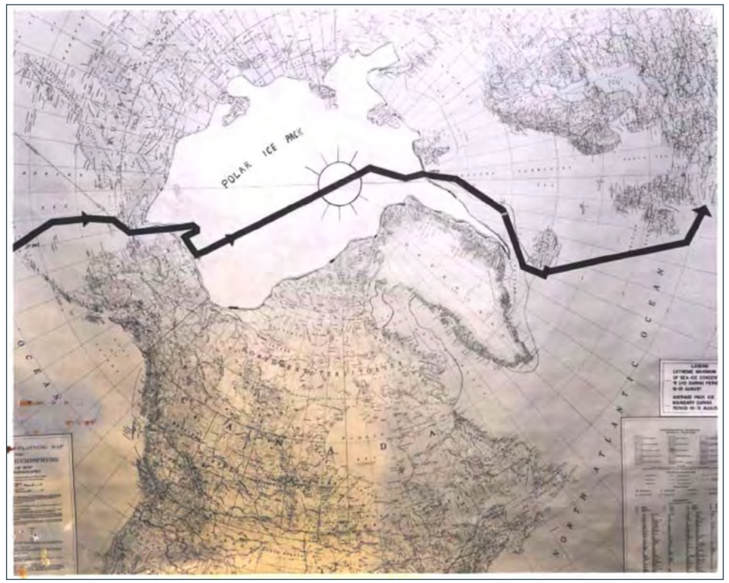
U.S. Navy Assesses Operational Readiness in the Arctic

In March, the U.S. Navy deployed two of its *Los Angeles*-class submarines to the Arctic along with scientists, divers, and unmanned vehicle operators, all as part of a five-week training exercise called ICEX.







Eisenhower aide James Hagerty put together a map of the *Nautilus*'s voyage for his boss soon after the trip ended.

When so much is going on elsewhere in the world, one might wonder why the Navy would send valuable assets and personnel to the far north. The Arctic Ocean is warming at an unprecedented rate, opening the sea routes that U.S. Navy Rear Admiral Robert E. Peary dreamed of discovering a century ago in his quest to reach the North Pole.

The Navy's Arctic Roadmap [http://www.navy.mil/docs/USN_arctic_roadmap.pdf] includes an assessment of how ice coverage will change in the Arctic, predicting that in the coming decades previously ice covered waterways will open for maritime use for several weeks each year. In one example, the Northern Sea Route experienced only two weeks of open water in 2012, but is predicted to have nine weeks of open water by 2030.

Arctic and non-Arctic countries alike are beginning to recognize the strategic importance of an opening Arctic and are planning accordingly. The Navy, however, is not a newcomer to the Arctic. For decades, Navy Sailors have silently served beneath the ice, conducting submarine training exercises in the Arctic Ocean.

Starting in the late 1940s, the Navy's Submarine Force began exploring the potential for under-ice operations. Initially using diesel submarines, short excursions were made beneath the marginal ice zone in the North Atlantic Ocean, the Bering and Chukchi Seas, and the waters off the Antarctic continent.

In 1958, the nuclear-powered USS *Nautilus* (SSN 571) made the first crossing of the Arctic Ocean beneath the pack ice. This was followed in 1960 by the USS *Sargo* (SSN 583), the first submarine to conduct a winter Bering Strait transit and subsequent North Pole surfacing.

Analysis of data collected by the Submarine Force during these and subsequent exercises contributes to a broader understanding of the Arctic environment, including the changing patterns, extent, and volume of sea ice cover over time. The Navy also collaborates with the scientific community to share data that could not be collected from any source other than submarines operating under the multi-year pack ice.

Continued expansion of the ICEX mission increases the Submarine Force's proficiency at operating in such a demanding environment and is important to national defense. The tempo of ICEX recently restored from once every three years to once every two years and included operations on a temporary ice camp. This year, Ice Camp SARGO hosted over 200 participants, including multinational civilian and active duty scientists.

Scientists from the Massachusetts Institute of Technology deployed a sophisticated unmanned underwater vehicle (UUV) to study how sound travels through the icy water below the Navy's floating ice camp.

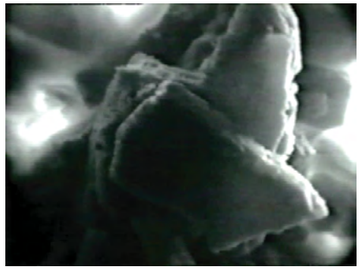
The National Ice Center, a multi-agency operational center led by the U.S. Navy and the National Oceanic and Atmospheric Administration, collaborated with the University of Washington in selecting the location of the ice camp, and the Naval Research Laboratory conducted Light Detection and Ranging (LIDAR) overflights to assess ice floe characteristics.

The Applied Physics Laboratory at the University of Washington deployed an Arctic Tracking Range System (ATRS) to monitor submarine operations. Tracking submarine operations and providing those data in real-time is a primary mission of ICEX.

The submarine tracking range was installed in the center of the ice camp with individual battery-powered Remote Tracking Receiver (RTR) nodes deployed in the ice field surrounding the camp. Each RTR node is composed of a below-ice hydrophone connected to an electronics housing on the ice surface.

The hydrophone receives acoustic tracking pulses from custom synchronous transmitters installed on the submarines or UUVs. The RTR surface expression houses a single-board computer, an integrated GPS receiver, and a wireless transmitter. The GPS precision time signal is used to generate timestamps of acoustic pulse travel time from the tracked object to the RTR hydrophone. Each RTR wirelessly transmits encrypted timestamps and node location to the ATRS. The ATRS uses at least three RTR data packets and a trilateration algorithm to calculate the tracked object position and display its location on a tracking grid. The tracking grid display allows camp personnel to monitor exercise progress and ensure submarine safety.

Side scan sonar pods mounted to a submarine sail



A deep ice-keel as seen through the SRVS camera

The ATRS also uses hydrophones directly cabled to the main system in camp. In this mode of operation the ATRS timestamps the time of travel from the tracked object to each hydrophone. Just like the RTR-based mode of operation, the timestamps from each hydrophone are processed to determine a tracked object position for display on the tracking grid.

The RTR nodes are preferred over cabled hydrophones in the changing Arctic environment, avoiding issues with damaged cables due to the dynamic nature of the ice. The stand-alone wireless RTR nodes are robust enough to withstand ice movement and can be deployed farther from camp for expanded range geometries.

This is just one example of the types of operational considerations that need to be taken into account when collecting scientific data in the extreme and dynamic environment of the Arctic.

The Navy is also supporting research and development into extreme-cold-weather modifications for systems and equipment to improve sustained observational capabilities in the challenging Arctic environment. Gaps in satellite communications, which are limited or non-existent above 70 degrees north latitude, pose a risk to operations in the Arctic and have led the Navy to investigate new technologies for increasing communication capabilities.

Because of the difficulty and the cost of gathering data in Arctic conditions, Arctic scientists see the region as an area where cooperation is not only encouraged, but essential. ICEX 2016 included participants from U.S. governmental agencies, academia, and international partners.

In the coming decades, the Navy may deploy surface ships into this remote region. Before that happens, scientists and operators need to understand more about the complex Arctic environment.

"The U.S. Navy must be ready to operate in all the world's oceans, including the Arctic, as we have done for many decades," said Rear Admiral Tim Gallaudet, Oceanographer of the Navy. "The Arctic is a major driver of global climate and weather. The diminishing sea ice is gradually opening the region to the potential for increased economic activity including commercial shipping, fishing, oil and mineral extraction, and tourism. We need to understand and predict the harsh physical conditions that fundamentally constrain operation here in the region."

ICEX 2018 will continue a long-standing Navy effort to ensure that its systems, sensors, platforms, and personnel are capable of operating proficiently in the Arctic while also advancing important research in this region.

Sean Lastuka is the lead engineer for ICEX Arctic Tracking Range System, Applied Physics Laboratory, University of Washington. Dr. Heather Havens is an Arctic policy analyst for Navy Strategy & Policy Directorate (OPNAV N51).

ICEX 2016 Participants

Canada
- Royal Canadian Air Force
- Royal Canadian Air Force 440 Transport Squadron (Airlift Support)
- Royal Canadian Navy (Range Safety Officer, camp support)
- Royal Canadian Navy Fleet Diving Unit Pacific (Diving)

Norway
- Norwegian Defense Research Establishment (Arctic Collaboration observer)

United Kingdom
- Royal Navy (Range Safety Officer, camp supports submarine riders)

United States
- Alaska Air National Guard 212th Rescue Squadron (SAR training)
- Alaska Air National Guard 176th Wing (Air Drop)
- Alaska Command
- Applied Physics Laboratory, University of Washington (Camp Logistics and Tracking Range)
- Bureau of Safety and Environmental Enforcement
- Expeditionary Combat Camera
- Fleet Weather Center
- Massachusetts Institute of Technology (UUV Ops)
- Mobile Diving Salvage Unit (MDSU) 2 (Diving)
- National Science Foundation
- Naval Postgraduate School (Hydro Measurements, Acoustic Recording, Ocean Flux Buoy, UUV Ops, UAV Arctic Ops)
- Naval Research Laboratory (Aerial Ice Thickness Surveys)
- Naval Undersea Warfare Center (Camp support)
- Navy Meteorological Operations Center (Weather/ice support, NAVO Tethered Profiler)
- National/Naval Ice Center (NIC) (Ice Floe RADARSAT imagery and tracking)
- National Weather Center
- Office of Naval Research
- SEAL Delivery Vehicle Team 1 (Diving)
- Submarine Force, U.S. Atlantic Fleet
- Submarine Force, U.S. Pacific Fleet
- Submarine Squadron 11 (Range Safety Officer, camp support, medical officer)
- Undersea Warfighting Development Center (UWDC), Detachment Arctic Submarine Laboratory (ICEX coordinator and director of ICEX)
- Undersea Warfighting Development Center (UWDC), Detachment Tactical Analysis Group (TAG) (Submarine Tactical Development)
- U.S. Army Natick Soldier RD&E Center (Shelter Test and Evaluation)

by Lt. Cmdr. David Payne

The Frigid Frontier of the Arctic

Submarine waterspace deconflicted with five countries, three SUBNOTEs reviewed and issued, chat and voice comms with three submarines and two Maritime Patrol Reconnaissance Aircraft (MPRA), and one Medical Evacuation coordinated with Fleet Medical and host nation. All in a day's work for the Task Force 69 (TF69) submarine watch officer. Often with only a couple months of on-the-job experience, this junior officer is the hub for multi-national submarine operations in the fastest growing, most complex and dynamic undersea area of operation on the planet.

Strategic Significance

Throughout history, humans have explored new lands and expanded their territory, primarily driven by the quest for resources and commerce. Today is no exception. Global commerce grew at an estimated rate of 3.1% in 2015, a rate that is expected to rise to 3.6% by 2017,[1] driving an increased need for energy and other natural resources. As 70% of the earth is covered by water, countries are desperately trying to lay claim to the wealth of resources that lay beneath the waves. Highly publicized land reclamation efforts by China in the South China Sea are but one example of the intense desire to stake a claim on energy and food supplies.

A less noticed, but perhaps even more important, area of future exploration is the Arctic. A 2008 study estimated 13% of the world's undiscovered oil reserves were in the Arctic (about 90 billion barrels of oil and 44 billion barrels of natural gas).[2] With the shrinking ice cap, the Arctic is quickly becoming a flurry of activity as these new oil supplies and shipping routes are becoming accessible. According Russian Navy Commander, Adm. Viktor Chirkov, "From January 2014 to March 2015 the intensity of patrols by [Russian] submarines has risen by almost 50 percent as compared to 2013 [which] is logical and necessary to guarantee the security of the state."[3]

The United States has long recognized the significance of the Arctic, and the U.S. Navy has played a large part in exploration and regional security. The U.S. Submarine Force operated near the marginal ice zone in the Arctic well before USS *Nautilus*' (SSN 571) first under-ice transit between the Pacific and Atlantic Oceans in 1958, and USS *Skate*'s (SSN 578) subsequent first surfacing through the polar ice cap at the North Pole in 1959. Since that time, the Submarine Force has freely navigated the Arctic and conducted over 26 extremely challenging exercises under the ice, including torpedo firing and recovery.

The current Department of Defense Strategy for the Arctic defines an end state of "a secure and stable region where U.S. national interests are safeguarded, the U.S. homeland is protected, and nations work cooperatively to address challenges."[4] To achieve these goals, we must ensure security for the area, support safety for its inhabitants, and promote defense cooperation, all while preparing to respond to a wide range of challenges and contingencies. The Submarine Force, specifically Submarine Group 8, TF69, and assigned units, are at the forefront of meeting these challenges. They routinely conduct operations and exercises with allies to maintain peak operational proficiency in a challenging and unforgiving environment.

As the Theater Anti-Submarine Warfare (TASW) commander for U.S. 6th Fleet, TF69 executes the full spectrum of TASW and employs a full range of sensors and platforms across the sea and air. Large-scale multinational exercises are routine and serve to build and foster relationships as well as validate tactics and procedures and improve proficiency. These exercises also provide excellent opportunities for collaboration ashore as ships and aircraft visit allied ports and air bases. Annually, NATO conducts the large-scale TASW exercise DYNAMIC MONGOOSE in the Norwegian Sea. In 2015, this exercise included four submarines and 13 surface ships from 11 partner nations.

A Team of Task Forces

Commander, Task Force 67 (TF67) (MPRA) and Commander, Task Force 65 (TF65) (Surface Forces) are integral members of the North Atlantic TASW team. TF67 aircraft routinely participate in TASW operations and exercises, operating out of forward staging bases in Reykjavik, Iceland; Lossiemouth, UK; and Andøya, Norway. TF67 primarily flies P-3C Orion aircraft, although P-8A Poseidon aircraft are expected to begin deploying to the 6th Fleet area of operations in the near future.

TF65 guided missile destroyers (DDGs) also routinely participate in North Atlantic TASW operations and exercises. The increase in DDGs forward deployed to Rota, Spain provides the TASW commander significant flexibility and opportunity for involvement of these highly capable assets.

USS Seawolf (SSN 21) Arctic Transit

The Submarine Force routinely operates under the Arctic ice cap, using the area as a rapid route between the Atlantic and Pacific Oceans. A recent example of such a transit was the USS *Seawolf* (SSN 21). *Seawolf* is homeported in Bangor, Wash. as part of Submarine Development Squadron 5 but was given orders to complete a European theater deployment in 2015. The boat transited to and from its deployment in the northern Atlantic via the Arctic. According to the ship's commanding officer, Cmdr. Jeff Bierley, "We conducted two polar transits, including a routine surfacing at the North Pole. Operations under the Arctic are part of the Navy's continued commitment to maintain access to all international seas, and *Seawolf* was just part of that commitment."[5]

In addition to advancing fleet and national objectives, transiting the Arctic is a unique and rewarding experience for Submariners. A trip to the North Pole via air or icebreaker can cost upward of $20,000.[6] Even if one is fortunate enough to be able to take one of those trips, nothing compares to surfacing through the ice in a submarine. As Yeoman 3rd Class Felipe Aparicio explains, "Surfacing at the North Pole was awesome. As you push through the surface, it takes your breath away. You feel the ice hit the hull of the boat and you hear thumping back and forth all around you; then it just stops. It was a memorable experience. We got out of the boat, and the best way to describe the North Pole is that it's a cold, snowy desert."

The opportunity and activity in the Arctic will only increase in the years to come, and 6th Fleet and TF69 are well-poised to dominate the undersea domain now and far into the future.

Lt. Cmdr. Payne is the Chief of Staff for Submarine Group 8 and Task Force 69.

End Notes:

1 International Monetary Fund, World Economic Outlook Update, January 2016, http://www.imf.org/external/pubs/ft/weo/2016/update/01.

2 United States Geological Survey, 90 Billion Barrels of Oil and 1,670 Trillion Cubic Feet of Natural Gas Assessed in the Arctic, July 2008, http://www.usgs.gov/newsroom/article.asp?ID=1980.

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5 Mass Communication Specialist 2nd Class Amanda R. Gray, Seawolf Completes Six-Month Arctic Deployment, August 2015, http://www.navy.mil/submit/display.asp?story_id=90772.

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Why Submarines Operate in the Arctic?

by Lt. Cmdr. Tom Weiler

The Ice Exercise (ICEX) Program is an important means by which our Submarine Force develops and hones its operational and warfighting skills in the unique and challenging Arctic environment.

The continents of the Northern Hemisphere—Europe, Asia, and North America—all share the Arctic Ocean, yet the Arctic region is primarily a maritime domain and a critical waterway that connects the Atlantic and Pacific Oceans. Freedom of the seas remains a top national priority, and preserving the rights and duties relating to navigation in the Arctic region supports our ability to exercise these rights throughout the world.

The United States' strategy in the Arctic is codified in the documents described below, all of which highlight the important role of the Arctic in our national defense.

- A **National Strategy for the Arctic Region** was released by the President in May 2013. It states that the United States will "Seek to maintain and preserve the Arctic region as an area free of conflict, acting in concert with allies, partners, and other interested parties."
- The **Department of Defense Arctic Strategy,** released in November 2013, listed four objectives: ensure security, support safety, promote defense cooperation, and prepare for a wide range of challenges.
- The February 2014 **U.S. Navy Arctic Roadmap** requires the Navy to be fully mission-capable in the Arctic.
- **Executive Order 13689, Enhancing Coordination of National Efforts in the Arctic** was signed in January 2015.

Through its ICEX Program, the Submarine Force supports all of these national objectives. At the same time, ICEX serves as a model and a potential springboard for other naval forces, DoD and interagency organizations, and partner nations to test and improve their own Arctic capabilities.

To meet these national objectives, the Submarine Force must overcome the operational challenges identified in the Arctic Environment (page 10). These challenges impact many ways in which a submarine operates and fights. ICEX is part of the process by which we evaluate and improve our combat systems, sonar systems, communication systems, and navigation systems in this challenging operational environment.

Arctic Submarine Laboratory (ASL) serves as the focal point for submarine arctic operations, coordinating arctic cruise planning, embarking experienced Arctic Operations Specialists, maintaining the Navy's corporate knowledge on arctic matters, and developing/installing special equipment used to enhance the safety and efficiency of under-ice operations.

USS *Skate* (SSN-578) above the Arctic Circle in 1959.

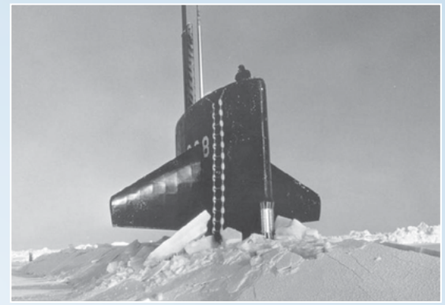
History of ICEX Operations

To support U.S. strategic objectives, our submarines need to maintain the ability to operate and fight in the Arctic. ICEX, along with other routine Arctic transits, is the long-standing means by which our Submarine Force develops and hones its Arctic operational and warfighting skills to meet these challenges.

Starting in the late 1940s, the Submarine Force began exploring the potential for under-ice operations. Initially using diesel submarines, short excursions were made beneath the Marginal Ice Zone (MIZ) in the North Atlantic Ocean, the Bering and Chukchi Seas, and the waters off the Antarctic continent.

The lessons learned from these cruises were put to outstanding use when, in 1958, the nuclear-powered USS *Nautilus* made the first crossing of the Arctic Ocean beneath the pack ice.

The USS *Nautilus* cruise was followed in quick succession by other cruises using USS *Skate*-class submarines. These cruises, coupled with tests conducted in the ASL Experimental Ice Pool, helped define the capabilities required to operate beneath the Arctic ice canopy. Starting in the late 1960s and running through the 1990s, the bulk of the ICEX missions were carried out by USS



USS *Whale* (SSN 638), North Pole, 1969

Sturgeon-class submarines. These boats were designed from the keel up to be fully Arctic capable and, as such, could prowl the front lines of the Cold War. In the mid-1980s, Great Britain's Royal Navy joined the ICEX Program, reflecting our nations' shared interest of maintaining Arctic/cold water operability.

Throughout this period, at least one U.S. submarine deployed to the Arctic every year, with some years seeing five or six under-ice cruises. The purpose of these deployments was to maintain our submarines and crews ready to operate and, if necessary, fight in the Arctic. Aspects of submarine operations addressed include the following.

Submarine OPERABILITY issues, such as:

- How to operate in extremely cold water
- How to surface through the ice
- How to find ice that a submarine could surface through
- How to navigate in high latitudes with no external references
- How to communicate when ice pack blocks most radio signals
- How to avoid ice keels, which can extend almost 200 feet below the ocean's surface

Submarine TACTICAL issues, such as:

- Sonar performance
- Weapon performance
- Development of Arctic-unique tactics

Arctic ENVIRONMENTAL aspects that influence both operability and tactics, including:

- Ice mechanics and distribution
- Location of shallow areas in a relatively uncharted ocean
- Low density water, which drastically affects submarine ballasting

These cruises improved our procedures and equipment, enabling our submarines to operate freely throughout the Arctic Ocean. Each cruise also enriches the crews involved with valuable and memorable experiences.

The SCICEX Program

In 1993, the Submarine Force branched into a new venture of dedicated cruises in support of civilian environmental science. Although ICEX cruises had regularly collected data for individual scientists before

USS *Honolulu* (SSN 718) during ICEX 2003

1993, this marked the first time that a team of civilian scientists was embarked and the submarine assigned exclusively to support their data collection. Thus began the Science Ice Exercise (SCICEX) Program.

A year later, the Submarine Force signed a Memorandum of Agreement (MOA) with the National Science Foundation (NSF) and the Office of Naval Research (ONR) to conduct annual SCICEX cruises. Five of these were carried out between 1995 and 1999. Although useful data were collected for some of the participating scientists, the demands on the Navy's submarine and budget resources required that dedicated cruises be discontinued following the 1999 cruise.

In 2000, a second MOA was signed that established a new phase of scientific cooperation: the SCICEX Accommodation cruises. Under this agreement, submarines on unclassified missions would spend a portion of their time collecting data requested by a civilian Science Advisory Committee. This is done without any major modifications to the submarine and uses only the embarked Navy/ASL personnel. Between 2000 and 2005, four Accommodation cruises were completed under this new MOA. In 2010, the SCICEX Science Advisory Committee completed a comprehensive SCICEX Science Plan to identify all of the data they would like submarines to collect. With this in hand, several submarines entering the Arctic Ocean since 2010 have collected SCICEX data.

Partner Nations Arctic Cooperation

ICEX 2016 is a multinational exercise that includes naval personnel from both Great Britain and Canada as well as an observer from Norway.

The U.S. Navy has no closer partner than Great Britain's Royal Navy, and nowhere is this relationship closer than with our submarine forces. The cooperation in Arctic exercises is just one example of the shared vision and resources our navies enjoy. This cooperation is evidenced by the inclusion of Royal Navy representatives as part of the U.S. Navy's Arctic Review Group, which is the governing committee for conducting the ICEX Program. The Royal Navy uses ASL Arctic operations specialists on its Arctic deployments, and U.S. submarines frequently embark Royal Navy officers when deploying to the Arctic.

Since 1986, nearly every tactical exercise conducted in the Arctic has involved both U.S. Navy and Royal Navy submarines. This has allowed both navies to continue to develop and maintain their Arctic warfighting expertise.

Our cooperation has also resulted in a mutually beneficial exchange of technologies and procedures. For instance, in the 1980s, the U.S. Navy relied exclusively on high frequency sonars for ice avoidance while the Royal Navy was using optical systems. As a result of the shared ICEX Program, the U.S. and UK navies now use both types of systems, thus enhancing their arctic operability and safety.

Although the Royal Navy does not have a submarine participating in ICEX 2016, they have provided personnel as ice camp watch standers, and several Royal Navy submarine officers are riding the USS *Hartford* (SSN 768) and USS *Hampton* (SSN 767) to gain experience in Arctic operations under the ice pack. The participation of the Royal Navy in ICEX 2016 is the continuation of a long-standing, mutually beneficial relationship.

During the 1980s and 1990s, the U.S. Submarine Force conducted numerous joint Arctic exercises with the Canadian military. The end of the Cold War reduced both nations' focus on northern affairs, and our interactions with the Canadians slowed. Recent years have brought a renewed interest in the Arctic, and our navies are now again cooperating in Arctic exercises. Starting with ICEX 2011, Canada has had a presence at our ice camps. Besides providing watch standers for ICEX 2016, the Royal Canadian Air Force also participated in this year's ICEX with a Twin Otter transport aircraft assisting in personnel and equipment movement between Deadhorse, Alaska, near Prudhoe Bay, and Ice Camp SARGO. Additionally, Vice Adm. Norman, the Commander of the Royal Canadian Navy (CNO equivalent), visited Ice Camp SARGO for an overnight.

Current ICEX Focus

For more than 75 years, the U.S. Submarine Force has been involved in exploring the Arctic in an effort to ensure access to all of the world's oceans and waterways. Our current focus is a continuation of that effort and of monitoring changes in the Arctic.

The ICEX Program continues today as the proving ground for submarine Arctic operability and warfighting. Since 2000, the focus of ICEX has shifted to ensuring the safe operation and tactical capability of all Fast Attack classes. Any of these newer submarines may someday be called upon to fight in ice-covered waters or, at the least, transit the Arctic and make the arduous Bering Strait transit during a period of extensive ice cover. Therefore, *Los Angeles*-, *Seawolf*-, and *Virginia*-class submarines have all conducted basic Arctic trials, and all classes conduct routine operations in the Arctic beyond those associated with ICEX.

Flags flying above Camp SARGO bear witness to the international cooperation involved with the success of ICEX 2016.

Connecticut's Submarine Centennial

by Lt. Cmdr. Reginald Preston

Photo by Lt. j.g. Daniel Mongiove

State Sen. Paul Formica presents Capt. Paul Whitescarver a joint proclamation during the SUBASE and Naval Submarine School (SUBSCOL) centennial ceremony on the *Nautilus*.

The site was, according to Rear Adm. (Sel.) Albert W. Grant in remarks to then Navy Secretary Josephus Daniels, "as well suited as a shore station for submarines as if built for that purpose." Two months later, in October 1915, seven *D*-class and *G*-class submarines sailed up the Thames River in the Southeastern corner of Connecticut and arrived at what was a simple coaling station and supply depot on the Eastern bank of the river. The naval station, found nearly abandoned upon their arrival, had almost been closed permanently just years earlier, saved at the last minute by Connecticut Rep. Edwin W. Higgins.

Today's Naval Submarine Base New London hardly fits that early description and probably wouldn't be recognized by any of those early Submariners. It has been 100 years since the base was officially designated as the country's first permanent, continental submarine base. Cmdr. Yates Sterling, Jr. assumed command of the base and established the Submarine School on June 21, 1916. On June 21, 2016, Naval Submarine Base New London held an official ceremony to ring out the last century with a ceremonial eight bells before ringing in the next 100 years.

Connecticut Gov. Dannel Malloy and Rep. Joe Courtney joined Rear Adm. Jeff Trussler (Undersea Warfare Development Command) and Capt. Paul Whitescarver (Commanding Officer of Submarine Base New London) to commemorate the anniversary topside on Historic Ship *Nautilus* (SSN 571). Setting the scene, USS *California* (SSN 781) sailed down river in the opening moments of the ceremony, rendering honors to the submarine base, submarine school, and 100 years of service.

Today, Naval Submarine Base New London hosts over 70 tenant commands and 15 home-ported fast attack submarines forming Team New London. Speaking on the importance of the region to the Submarine Force then and now, Rear Adm. Trussler remarked, "The synergy that exists in Groton is the envy of all others in the Navy." Combining the facilities and schoolhouses on the base with the industrial base in the region and one-third of the fast attack fleet and their families has created what is famously known as the "Submarine Capital of the World." Noting Connecticut's long history in supporting the defense of the country as far back as the Revolutionary War, Gov. Malloy commented, "We celebrate 100 years at this spot, and we'll celebrate another 100 years at this spot. We will produce the greatest Navy, the greatest machines, the greatest fighting force and the most important fighting force, the Submarine Force, for years and years to come."

Photo by Lt. j.g. Daniel Mongiove

Rear Adm. Jeffrey Trussler speaks during the centennial ceremony held at the HSN and Submarine Force Library and Museum (SFLM).

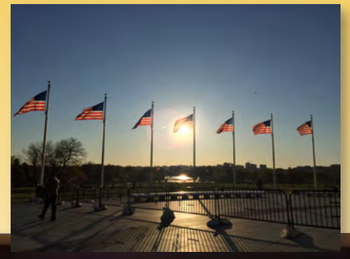
Lt Cmdr. Preston is the 16th Officer in Charge of Historic Ship *Nautilus* and the Director of the U.S. Navy Submarine Force Museum.

by Lt. Cmdr. Michael Huber

MEET THE 2015 SUBMARINE JUNIOR OFFICERS OF THE YEAR

2015 Junior Officers and their spouses met with Senator Murphy

Touring the U.S. Capitol



It's not every day you find a group of submarine junior officers roaming the nation's capital, but in early April, 11 Submariners and their spouses made their way to Washington, D.C. to be recognized as the 2015 Junior Officers of the Year (JOOYs).

The JOOY program recognizes junior officers of the Submarine Force who demonstrate superior seamanship, management, leadership, and tactical and technical knowledge. Submarine candidates are nominated by their command's junior officers and commanding officer and selected by their squadron commanders. Submarine tender candidates are selected by the ship's commanding officer.

"This symposium was a great chance to feel that our hard work and contributions as JOs is recognized and rewarded," said Lt. Nicholas Geraci, the Submarine Squadron 4 Junior Officer of the Year.

The JOOYs' week in Washington began on Tuesday, April 5. Their daytime agenda included a visit to Capitol Hill for meetings with congressmen and a tour of the U.S. Capitol. They also enjoyed tours of the National Museum of the United States Navy and the Pentagon. The junior officers also received a classified tour highlighting new technologies being developed for submarines at the Lockheed Martin facility in Manassas, Va. They also spent time at the Pentagon and Washington Navy Yard meeting with Rear Adm. Charles Richard, Director, Undersea Warfare Division; Vice Adm. Robert Thomas, Director, Navy Staff; and Adm. James Caldwell, Director, Naval Nuclear Propulsion Program. Their visit culminated with the D.C.-area Submarine Birthday Ball Friday evening.

"I envy you all. If I could sign up to go back to a boat today, I would!" said Vice Adm. Thomas during his meeting with the junior officers and spouses.

"I appreciated the office calls with each admiral. I enjoyed seeing a senior Submariner's point of view and being allowed an opportunity to ask questions," commented Lt. Eric Anderson, the Submarine Squadron 1 Junior Officer of the Year.

"The submarine lifestyle is very challenging, both for the officer and especially for his or her family," commented Lt. Nick Geraci. "The conversations we had with many successful Submariners gave me a better outlook on the prospect of a career in submarines and gave me the tools I think I will need in the coming year to make the best decision for my family."

As representatives from all corners of the Submarine Force, the junior officers had the opportunity to tell their stories to some senior leaders. Rear Adm. Richard had the opportunity to tell them what is coming down the road and solicit some genuine feedback on how a JO thinks we can improve our submarines. In one example, he proposed that "answering the phone in port is one of the most dreaded events that can occur onboard a submarine." Although everyone got a quick laugh, they agreed. "We have to take advantage of the technology that exists today to continue to make our Submarine Force better," said Rear Adm Richard.

During the tour of the Lockheed Martin Facility in Manassas Va., the junior officers had the opportunity to see first-hand some new equipment that is making its way to the fleet. This tour was for many the highlight of the trip. "This was by far my favorite part of the trip" commented Lt. Michael Plummer the Submarine Squadron 12 Junior Officer of the Year. "Maybe I'll see this stuff on a boat one day," added Lt. Plummer. Inside the Area 51 lab you couldn't go more than a few minutes without hearing "wow, that's awesome" or "this is cool, when can I have one of those."

Everyone who met the junior officers was excited to take time out of their schedules to have a chat, including being stopped in the hall by Vice Adm. Joseph Mulloy, a fellow Submariner who serves as the Deputy CNO for Integration of Capabilities and Resources, N8. It was refreshing for the officers and their spouses to hear a perspective on the Submarine Force and the Navy beyond their division. The big picture can sometimes get lost in the daily life of a submarine JO. The JOOYs emphasized job satisfaction as a big reward of being a Submariner, including getting to know a small crew, traveling to different ports, and completing missions.

The facility has a 59,000 square foot ASW laboratory that supports all facets of combat system development for the Submarine Fleet. The ASW lab enables development, integration, test, production, and support for all six submarine variants (688, 688i, *Seawolf*, SSGN, SSBN, *Virginia* Blk I/II, and *Virginia* Blk III/IV). The ASW lab contains SQQ-89 surface ship and surveillance sonar development efforts. Additionally, three specialty labs were created within the ASW lab spaces. The first, the Attack Center, is set up to mimic a *Virginia*-class submarine configuration in order to support the Advanced Processor Build (APB) advanced development program. The second, an innovation lab called Area 51, provides new technology prototype space in an area that closely resembles the physical submarine control room and wardroom. And finally, Area 51 brings all of the displays from the three ASW platform types (submarine, surface, surveillance) together in one location to aid in exploring collaborative ASW prosecution.

Along with talking about work-related activities, the spouses had a chance to express thoughts and concerns. Keeping the family connection strong is not always easy. Adm. Caldwell and his wife, Kim, hosted the junior officers and spouses for lunch at Naval Reactors. This offered a great opportunity for the spouses to interact with a Navy wife who has a lot of experience. Family separation is one of the biggest challenges of being a Submariner. Even with the separation, though, the rewards of a submarine career far outweigh the challenges. During lunch, Adm. Caldwell and Kim shared some of their memories from various duty stations. "Hawaii was our favorite place" said Kim. Lt. Nick Geraci and his wife Katie, recently transferred to Hawaii for shore tour and were "really excited to explore all the islands" and appreciated the recommendations from the Caldwells.

In addition to speaking with some Submarine Force and Navy leadership, the group received a briefing from the Submarine Force community manager's office (OPNAV N133) about some of the programs and opportunities available to junior officers. The JOs and spouses also had an opportunity to provide feedback on a range of personnel-related topics, including graduate education. To learn more about graduate education opportunities see XYZXYZ later in this edition.

Junior Officers of the Year 2015

Lt. Eric Anderson
USS *Texas* (SSN 775)

Lt. Tyler Arp
USS *Hampton* (SSN 767)

Lt. Bryan Boldon
USS *Cheyenne* (SSN 773)

Lt. Stephen Edwards
USS *Topeka* (SSN 754)

Lt. Ryan Ellwood
USS *Pennsylvania* (SSBN 735)(G)

Lt. Nicholas Geraci
USS *New Hampshire* (SSN 778)

Lt. Katherine Irgens
USS *Georgia* (SSGN 729)(G)

Lt. Richard Lauber
USS *Connecticut* (SSN 22)

Lt.j.g. Michael Plummer
USS *New Mexico* (SSN 779)

Lt. Kevin Rader
USS *Montpelier* (SSN 765)

Lt. Peter Wenke
USS *Michigan* (SSGN 727)(G)

Lt. Matt White
USS *Tennessee* (SSBN 734)(G)

Lt. Eric Moore
USS *Frank Cable* (AS 40)

Graduate Education Programs for U.S. Naval Officers

Navy leadership recognizes the value and importance of advanced education. There is a constant demand for quality officers to fill other Navy core billets, however, thereby limiting opportunity for resident advanced education. All eligible Navy officers are encouraged to pursue graduate education through one or more of the educational programs available to them. Following are the graduate degree programs available to Navy officers.

Arthur S. Moreau Program

The Arthur S. Moreau (ASM) program for post-masters study in international relations and strategy was developed to support the Navy's requirement for officers who are extremely knowledgeable in the formation and conduct of foreign policy, strategic planning, and decision-making processes at the highest levels of government.

The ASM program is available for O-4s (sel) and O-5s who have already completed a Politico-Military Master's program. For more information, see OPNAVINST 1500.72G or go to http://www.public.navy.mil/bupers-npc/reference/messages/Documents/NAVADMINS/NAV2013/NAV13171.txt.

Federal Executive Fellowship Program

The Federal Executive Fellowship (FEF) program was established in 1971 to give officers an opportunity to increase their understanding of policy development and national security decision making at the highest levels of government by participating as fellows at select non-profit research organizations (think tanks) and academic institutions.

Institutions include: The American Enterprise Institute, The Atlantic Council of the United States, The Brookings Institution, The Center for New American Security, Center for Strategic and International Studies, Weatherhead Center at Harvard University, Hudson Fellowship, Hoover Institute, The Rand Corporation, and Johns Hopkins University/Advanced Physics Laboratory.

The FEF program is a one-year program open to O-4s, O-5s, and O-6s. For more information, see OPNAVINST 1500.72G or go to http://www.public.navy.mil/bupers-npc/references/messages/Documents/NAVADMINS/NAV2015/NAV15159.txt.

Fleet Scholars Education Program

The Fleet Scholars Education Program (FSEP) is geared for junior and mid-level Unrestricted Line (URL) and Information Dominance Corps (IDC) officers. Selections are made and forwarded by community sponsors by Dec. 16. Communities have the following allocations: Aviation, 7; Surface, 7; Submarine, 4; Special Warfare, 3; Expeditionary Combat, 3; IDC, 6.

FSEP selectees can choose any accredited graduate school in the continental United States, Alaska, or Hawaii and attend for up to 24 months. Distance learning, medical, and legal education programs are not allowed. Those officers who have already received an advanced degree funded by the Navy are not eligible; this does not include those who earned a degree using the G.I. Bill, tuition assistance, or Navy College Program for Afloat College Education.

FSEP is a two-year program open to eligible O-2s and O-3s nominated by a Type Commander for one of four spots. For more information, go to http://www.public.navy.mil/bupers-npc/reference/messages/Documents/NAVADMINS/NAV2015/NAV15254.txt.

Graduate Education plus Teaching

The Graduate Education plus Teaching (GET) program provides the USNA with Unrestricted Line officers who are qualified academically and professionally to serve as teachers and role models for our future officers in the academic disciplines listed in the GET instruction and return them to the fleet in career-competitive assignments upon completion of their USNA tour. The GET program provides for one year of graduate education at either NPS or a selected civilian institution in the Baltimore, Md. or Washington, D.C. area directly followed by a two-year teaching assignment at the USNA as an officer-instructor.

The GET program lasts from two to three years and is open to O-2s and O-3s. For more information, see OPNAVINST 1524.2 or go to http://www.public.navy.mil/bupers-npc/reference/messages/Documents/NAVADMINS/NAV2014/NAV14213.txt.

Graduate Education Voucher

The Graduate Education Voucher (GEV) program was established to provide increased opportunity and incentive for selected Unrestricted Line (URL) officers who wish to obtain a graduate degree during off-duty hours. GEV participation enables selected URL officers, those determined to exhibit superior performance and potential for future contributions to the Navy, to earn a Navy-relevant master's degree leading to an approved subspecialty while meeting other Navy needs.

The GEV program is limited to a maximum of two years and is available for O-3s to O-5s. Additional information on the GEV program can be found at http://www.navycollege.navy.mil/gev/gev_home.html.

Junior Permanent Military Professor

Junior Permanent Military Professor (JPMP) officers help meet the demands for military instructors at the USNA. The JPMP program provides a stable source of officers in the grade of lieutenant commander (O-4) with the appropriate professional experience and academic preparation to teach at the USNA.

The JPMP component seeks post-department-head URL or IDC lieutenant commanders with relevant master's degrees and preferably with teaching experience to join the USNA faculty.

The USNA is authorized up to 40 JPMPs consisting entirely of lieutenant commander billets. Subject to available funding, JPMPs not already possessing a relevant master's degree may attend designated civilian institutions to obtain a master's degree.

The JPMP program is open to O-4s (including sel and post department heads). For more information, see OPNAVINST 1520.40B or go to http://www.public.navy.mil/bupers-npc/reference/messages/Documents/NAVADMINS/NAV2014/NAV14174.txt.

Leadership Education and Development (LEAD)

The Leadership Education and Development (LEAD) program provides graduate education and preparation for talented, highly qualified junior officers to serve as company officers at the U.S. Naval Academy (USNA) and for continued future service in the Navy or Marine Corps. The program develops students' abilities to think critically and analytically and focuses on the knowledge, skills, and abilities essential for understanding, designing, and conducting leader and team development.

Junior officers selected for this master's degree program will complete a 45-degree-credit program at The George Washington University (GWU) in a one-year period with classes both at GWU and USNA.

GWU will deliver a master's degree in Leadership Education and Development for USNA company officers (LEAD fellows) after one year of study. To best accomplish this program and in line with GWU's emphasis on cross-disciplinary initiatives, two departments in two different schools (Department of Organizational Sciences & Communication (OSC) in the Columbian College of Arts and Sciences (CCAS) and Department of Human and Organizational Learning (HOL) in the Graduate School of Education and Human Development (GSEHD)) will collaborate based on targeted areas of expertise and will share the teaching load. The degree will be housed in CCAS.

The LEAD program lasts from two to three years and is available to O-2s and O-3s. For more information, go to http://www.usna.edu/LEAD.

MIT-Woods Hole Oceanographic Institution

The MIT-Woods Hole Oceanographic Institution (MIT-WHOI) joint program offers a master's degree program for U.S. naval officers, and more than 75 officers have received this degree since it was first awarded in 1970. The U.S. Navy manages the initial application process for naval officers prior to consideration.

Two joint committees now consider naval officers for admission to the master's degree program: the Joint Committee for Applied Ocean Science and Engineering and the Joint Committee for Physical Oceanography. The master's degree program is suitable for motivated students with undergraduate degrees in geoscience, physics, chemistry, mathematics, or engineering. The MIT-WHOI program is designed to be completed in 27 months (two years and a summer). The first year is spent taking courses and beginning research with an adviser. In the second year, the student conducts research and thesis work, culminating in a master's thesis.

The MIT-WHOI program is open to O-3s and O-4s. More information can be found at http://mit.whoi.edu.

Naval Postgraduate School

The Naval Postgraduate School (NPS) provides an outstanding opportunity to complete a graduate degree in a variety of technical and non-technical programs. All interested applicants should explore the NPS website to collect information on various curriculums. After getting a detailer endorsement, applicants must complete the application process through the NPS website.

All NPS curriculum quotas are assigned by OPNAV to each community based on the needs of the Navy. As a result, a member's desired curriculum may not be offered for the member's community.

NPS opportunities are from one and a half to two years and are open to all officers. For more information, go to http://www.nps.edu.

Naval Postgraduate School Distance Learning

NPS is dedicated to providing relevant, high quality education anytime and anywhere. A variety of delivery methods are used to expand learning beyond the traditional classroom.

All officers are eligible for the NPS distance learning program. For more information, go to http://www.nps.edu/dl.

Olmsted Scholar Program

The Olmsted Scholar Program provides two years of graduate study using a foreign language while providing overseas cultural and travel opportunities. Olmsted scholars achieve fluency in a foreign language, gain a deep appreciation for foreign cultures, and acquire regional expertise by traveling and studying overseas. Olmsted scholars routinely receive degrees for their graduate study at foreign universities. Applicants should be available to commence language training in the summer/fall of the year of selection by the Olmsted Foundation, begin study at a foreign university the following year, and complete their studies two years later. The total time in the Olmsted Scholar Program, cannot exceed three years. Selectees must apply to a program length based on the NAVADMIN selection message.

The Olmstead Scholar Program is from two to three years and is open to all eligible officers. For more information, see OPNAVINST 1520.23C or go to http://www.navycollege.navy.mil/olmstead.html.

Politico-Military Master's

The Politico-Military Master's (PMM) program was developed to educate naval officers in politico-military affairs and strategic planning through graduate education at elite civilian institutions, which include Georgetown University, Harvard University, Johns Hopkins University, Stanford University, and Tufts University.

The PMM program lasts from one to two years and is available to O-3s, O-4s, and O-5s. For more information, see OPNAVINST 1500.72G or go to http://www.public.navy.mil/bupers-npc/reference/messages/Documents/NAVADMINS/NAV2015/NAV15152.txt.

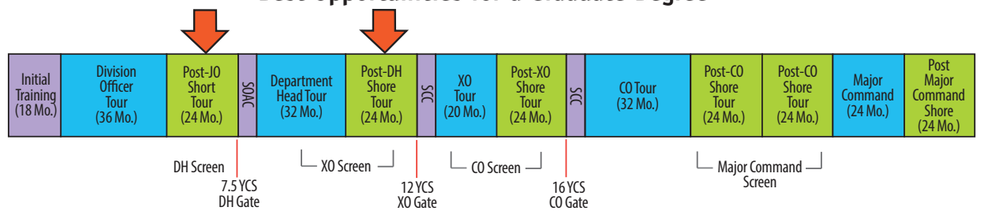
Permanent Military Professor

Permanent Military Professor (PMP) officers help meet the demands for senior military instructors at the USNA. Those officers are able to instruct and shape both entry-level and advanced portions of the academy's curriculum. PMPs provide a stable source of officers with the appropriate professional experience and academic preparation to teach at both the basic and advanced levels PMPs also help provide recruitment, counseling, and mentorship for more rotational military instructors.

The USNA is authorized up to 50 PMPs, consisting of at least 34 commander (O-5) billets and up to 16 captain (O-6) billets. PMPs selected to instruct at the USNA not already possessing a relevant PhD degree shall attend designated civilian institutions, NPS, or Air Force Institute of Technology (AFIT) to obtain one. Officers designated as PMPs are obligated to remain on active duty through statutory retirement: 28 years of active commissioned service for O-5s and 30 years for O-6s.

The PMP program is a permanent billet at the USNA and is open to O-5s and O-6s. For more information, see OPNAVINST 1520.40B or go to http://www.public.navy.mil/bupers-npc/officer/communitymanagers/restricted/Pages/PermanentMilitaryProffessor.aspx.

Best Opportunities for a Graduate Degree



Next Generation Submarines

by Jenny Roberts
Deputy Branch Head for Undersea Influence, OPNAV N97

THE ROLE OF SUBMARINES IS CHANGING AS THE U.S. NAVY MOVES FROM A PLATFORM-CENTRIC WARFIGHTING APPROACH TO ONE WHERE COLLECTIVE EFFECTS FROM THE DOMAIN ARE THE PRIORITY. THE NEXT GENERATION OF SUBMARINES WILL CONDUCT OPERATIONS BETWEEN 2040 AND THE END OF THE 21ST CENTURY (PROCURED FROM 2034 THROUGH ~2060). THE ROLE OF THESE SUBMARINES WILL BE CONSIDERABLY DIFFERENT FROM THAT OF TODAY WITH ANTICIPATED FUTURE CHALLENGES DRIVING UNDERSEA FORCE CAPABILITY NEEDS. ADDRESSING THESE CAPABILITY NEEDS MAY REQUIRE A NEW APPROACH TO SUBMARINE FORCE STRUCTURE. TO MAKE THIS DECISION, ADVANCED TECHNOLOGIES MUST BE DEVELOPED IN PARALLEL, COMPETED, AND EVALUATED FOR PERFORMANCE AND MILITARY UTILITY.

For decades, U.S. undersea forces have consisted of submarines, mines, and fixed undersea sensors, all with relatively stable mission sets and capability packages. Current trends are likely to substantially change the role and composition of U.S. undersea forces for that timeframe. These trends include:

- Air and surface forces facing more robust pressure from anti-access/area-denial (A2AD) systems require the Navy to lean more heavily on undersea forces to deliver effects. Undersea forces will be expected to defeat or disable those A2AD systems that are impeding general purpose forces from having greater access.
- The emergence of both friendly and unfriendly unmanned systems, especially mobile systems, will lead to a fundamentally different undersea environment.
- Undersea infrastructure from telecommunications to energy (oil, gas, and wind) to transportation (tunnels and bridges) is becoming an increasingly important part of our advanced global economy. This constitutes a rapidly growing class of "strategic assets" that needs to be both protected and, in the case of adversary systems, held at risk.
- The importance of the undersea is increasing and the range of undersea missions is growing. To meet national needs while the Submarine Force shrinks, fielding new capabilities that expand the geographic area that each submarine can influence, amplifying the manned platform with off-board unmanned system capabilities, and exploiting independent unmanned systems where practical will be essential.

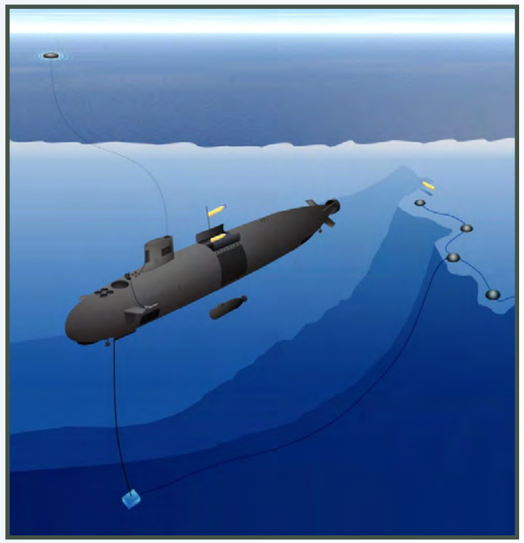
These trends create pressure far forward for new mission sets, an expanding area of regard for each submarine, and extended reach into shallow water and down to the seabed, all of which combine to suggest a significantly expanding role for unmanned systems. Accepting the assumption that integrating unmanned systems into the future undersea force is necessary does not mean that every future submarine needs to be a far-forward undersea hub for unmanned systems. There will likely continue to be a vital need for more traditional blue-water, open-ocean, sea-control operations. A submarine equipped to act as a staging base for unmanned undersea systems will, by necessity, include more payload volume, ocean interfaces, and support systems than a traditional submarine.

Addressing these new capability needs by attempting to design a hybrid platform that is meant to be able to perform both traditional and expanded undersea mission sets may provide the most effective path toward delivering the desired capabilities. On the other hand, there are good reasons to believe that such a hybrid submarine would involve performance compromises to both mission groups (traditional and unmanned system support) that are operationally unacceptable.

A submarine force made up of a mix of larger, unmanned system staging platforms and smaller, open-water, sea-control platforms might be the best way to deliver maximum effects. The larger submarine could focus on payload-intensive and geographically consistent tasking while the smaller submarine could focus on emergent peacetime needs and conventional deterrence tasking. While they might share some missions, each should be designed to optimize mission performance on a subset of the undersea mission areas. This complementary nature would provide a flexible set of employment options for theater commanders.

Figure 1 is a notional depiction of a large submarine with less emphasis on blue-water missions and more emphasis on operating far forward as an undersea base for both organic and off-board capabilities. This large submarine could:

- Expand undersea capabilities to the sea bed
- Employ large payloads
- Employ a broad and diverse portfolio of undersea weapons, payloads, and sensors to expand reach, both to full ocean depths and denied shallow littorals
- Provide the organic or off-board capability to target adversary systems and implant, service, employ, and protect U.S. and allied subsea systems
- Counter adversary undersea A2AD (organic or off-board)
- Interact with infrastructure and systems on the sea bed (organic or off-board)



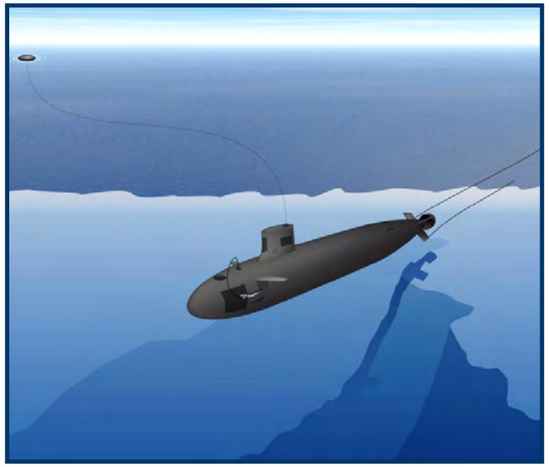
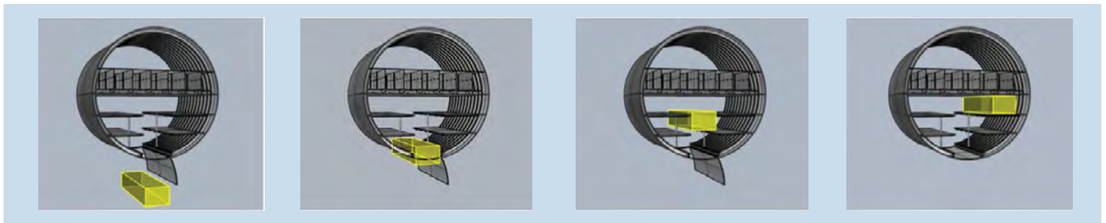


Figure 2 is a notional depiction of a smaller open-water attack submarine optimized for sea control, all-domain access, and other mobility-related missions with limited off-board system capability. This small submarine could:

- Provide optimized attributes for maneuver-based sea control and ISR missions
- Provide long-term (up to 12 hours), quiet, deep, precision zero-speed hovering capability
- Employ flexible payloads
- Interact with infrastructure and systems in the battlespace

Procurement of the next generation of submarines will begin in 2034. At that time, the submarine construction industrial base will have been building at least one 34-foot diameter SSN for the previous 35 years as well as a 43-foot diameter SSBN for the previous 13 years. The cost of designing and constructing both submarines will have been thoroughly scrubbed for maximum efficiency. A mixed submarine force would maintain both production lines while providing the ability to optimize, lean, or surge either line as foreign policy and/or mission needs dictate. It would also enable more flexibility in upgrades for each respective submarine type.

Availability of existing production lines, such as the *Virginia*-class or Ohio Replacement, may also increase the already significant pressure to make acquisition decisions early, too early, in the process. It may be financially appealing to use designs and technologies



Conceptual schematic for future UUV launch and recovery bay as part of a future submarine.

developed for the *Virginia*-class and Ohio Replacement for the next generation of submarines. Tried-and-true technologies that have already been designed, integrated, fabricated, and deployed would all but eliminate technical, schedule, and cost risks in an acquisition program. However, focusing too heavily on tried-and-true technologies might also eliminate the ability for next-generation submarines to meet the new roles and missions and face new threats in the mid to late 21st century.

Luckily undersea warfighting requirements are not based on what we think we can afford in a fiscally constrained environment. Next-generation submarine requirements will be based on national security needs just as every submarine class before it. Design choices, technology selection, and construction decisions will be based on informed analysis. Until the time it is appropriate to make those decisions, investments in key technologies will continue in earnest. Not all new technologies will be selected for the next generation of submarines, but the maturation of competing systems is required to inform acquisition decisions.

It is not possible to precisely define the nature of future problems we will face in specific detail. It is possible, however, to classify the challenges in general enough terms for us to take a lead angle on the development of the right capabilities to confront them. Industry and government technology providers have already begun addressing known needs that must be developed irrespective of whether a single hybrid submarine or a mixed force of submarines is selected.

These needs include but are not limited to:

- Integrated design tools that support full-spectrum trade space analysis
- Modeling, simulation, and prediction tools for shock, implosion, structures, stealth, and maintenance
- Through-hull communication and energy transfer
- Stealthy launch and recovery of off-board systems
- Main storage battery solutions
- Hull materials
- Modularity and platform upgradability

Equally, if not more important, are the capability needs that will drive the next-generation submarine design. Analysis and technology development in the following areas must be worked in earnest to inform whether pursuit of a mixed force is appropriate for the operating timeframe.

- Stationary and/or near-bottom operation
- Secure weapons launch
- Weapon defense
- Distributed propulsion
- Flexible horizontal and vertical payload launch and recovery
- Stationary situational awareness
- Stealth in an active environment
- Increased automation and its impact on crew size
- Increased payload fraction in 34-foot and 43-foot diameter submarines
- Maintenance needs and their impact on service life

The changing role and expanding missions of U.S. undersea forces has already begun, as has the requisite work to develop systems for advanced and new effects for the undersea domain. The roles, missions, and capabilities unique to submarines are being identified, as are those effects that can be delivered from other systems. Current efforts for next-generation submarines focus on identifying and formalizing future capability needs and maturing promising technologies. The Undersea Warfare Director's Future Capabilities Group is identifying future challenges that will drive the capability needs of next-generation submarines and synchronizing development efforts. The Program Executive Office, Submarines' Submarine Concept Team is identifying the design trade spaces for next-generation submarines. The Naval Research and Development Enterprise and industry partners continue to mature promising technologies and identify new technologies. The efforts to identify capability needs, evaluate trade space, and develop new technologies will grow into demonstration and prototype activities as well as detailed design concepts for the lead next generation of submarines. These efforts will also continue in their own right to inform subsequent submarine designs.

2016 Submarine Technology Symposium

The 28th Submarine Technology Symposium (STS), themed as "Innovation for Continued Undersea Superiority and Increased Contributions across the Battlespace from Under the Sea," was co-hosted by the Johns Hopkins University Applied Physics Laboratory (JHU/APL) and the Naval Submarine League (NSL) at JHU/APL in Laurel, Md. May 3-5. STS is an opportunity for individuals representing industry, laboratories, academia, the naval acquisition community, and the Submarine Force to listen to technical presentations, interact with hands-on exhibits, and collaborate across the submarine enterprise on technologies designed to enhance submarines' military value to national and theater military commanders.

This year, STS highlights included keynote addresses by Navy leaders, including Adm. John Richardson, Chief of Naval Operations (CNO); Adm. Frank Caldwell, Director, Naval Nuclear Propulsion Program; and Vice Adm. Dave Johnson, Principal Military Deputy Assistant Secretary of the Navy for Research, Development and Acquisition (DASN RD&A). Additionally, the audience heard interesting presentations by Submarine Force leaders including Vice Adm. Joe Tofalo, Commander, Submarine Forces (COMSUBFOR); Rear Adm. Fritz Roegge, Commander, Submarine Force, U.S. Pacific Fleet (COMSUBPAC); and Rear Adm. Chas Richard, Director, Undersea Warfare Division (N97).

The first STS was held in 1988 at the request of the Commander, U.S. Atlantic Fleet Submarine Force. The symposium, created to help expand research and development efforts related to submarines, continues to be the premier technical conference that provides a platform of collaboration across the enterprise to address critical technology challenges facing the future undersea domain.

The May 4 luncheon speaker, Adm. John Richardson, CNO, addresses STS 2016 attendees.

The five technical sessions presented at STS 2016 were chaired by representatives of industry, laboratories, academia, and the intelligence community. Presenting authors and exhibitors were selected by the STS Executive Committee, led by Rear Adm. Charlie Young, Retired, STS general chair, and Ms. Lisa Blodgett of JHU/APL, STS co-chair, from over 100 abstracts submitted. Abstracts were reviewed and judged on their technical quality and potential impact to the undersea warfare community. Each session was framed by a fleet speaker who tied that session's content to the symposium's theme and to their own operational experience. STS concluded with a roundtable discussion during which Submarine Force and U.S. Navy flag leadership responded to questions submitted by the STS audience.

STS 2016 was attended by over 500 representatives from government, military, academia, and industry and sold out a week before the event began. According to Rear Adm. Young, "This year's STS sellout attendance is an acknowledgment of the importance of our Submarine Force and the undersea warfare community in addressing the challenges to our country's national security." He also expressed his deep gratitude to Mr. Brad Wolf, JHU/APL, the 2016 STS program chair, and the symposium session chairs. "Mr. Wolf and the session chairs worked tirelessly to ensure the attendees heard relevant and interesting technical papers from a very diverse group of industry, government, and academic experts," Rear Adm. Young said.

"STS is a great forum to discuss potential technical solutions to major challenges in the undersea domain," said JHU/APL's Blodgett. "The keynote talks from senior leadership and the focused talks from fleet speakers provide excellent operational perspectives."

The next Submarine Technology Symposium is scheduled for May 9-11, 2017.

Rear Adm. Charlie Young, Retired, moderating Thursday's roundtable discussion consisting of Vice Adm. Joseph Tofalo (COMSUBFOR), Vice Adm. Dave Johnson (DASN RD&A), Rear Adm. Fritz Roegge (COMSUBPAC), Rear Adm. Michael Jabaley (Program Executive Office - Submarines), Rear Adm. (Sel) Nancy Norton (Warfare Integration for Information Warfare), and Rear Adm. Jeff Trussler (Undersea Warfighting Development Center).

SailorsFirst

Va. Gov. Signs Corpsmen to Civilian Health Care Bill

Approximately 20 corpsmen and staff members from Naval Medical Center Portsmouth (NMCP) attended the June 27 signing of a first-of-its-kind bill that established the Virginia Military Medics and Corpsmen (MMAC) Pilot Program.

The program allows active-duty medical personnel currently participating in MMAC to earn licenses or credentials that are recognized by civilian health care organizations.

Military medics and corpsmen receive extensive health care training while on active duty. When they transition to civilian life, their military health care experiences don't always translate into comparable certifications or licenses required for health care jobs. As a result, many veteran medics and corpsmen are unemployed because they cannot apply their skills immediately in civilian health care jobs.

"Per capita, we have more veterans than any other state in America," said McAuliffe. "One in ten Virginians is a veteran, and we are doing all that we can to integrate them into our workforce. The medics and corpsmen have real-time field experience, and they are a natural fit into our health care workforce."

Efforts had already been underway to translate veterans' military medical experience into academic credit and shorten the pathway to obtaining various civilian credentials. However, in health care, veterans may still need to spend several years in a college program before they can obtain a credential.

The MMAC Program will be accepting applications from qualified service members this fall. To learn more, visit http://www.dvs.virginia.gov/ or call the MMAC Program Manager at 804-786-0571.

Navy Continues Review of Enlisted Rating Titles

Secretary of the Navy Ray Mabus recently met with his leadership team to discuss the service's enlisted rating titles review.

During the meeting, senior Navy leaders, agreed to develop a new approach to enlisted ratings that provides greater detailing flexibility, training and credentialing opportunities, is more gender inclusive, and ultimately translates Navy occupations more clearly to the American public.

"As we move to achieve full integration of the force, this is an opportunity to update position titles and descriptions to be more inclusive and better translate occupation and skill sets to prospective employers when Sailors and Marines leave the service," said Mabus.

The Navy envisions a point where some combinations of today's rates, with similar training and experience, can easily cross into the occupations of similar rates with a limited amount of additional training or experience. This has the potential to enhance career flexibility and detailing options for our Sailors while improving "fit"—getting the right Sailors with the right skills into the right billets across the fleet.

Photo by Chief Mass Communication Specialist Kenneth G. Takada

Cmdr. Melvyn Naidas, Gold crew commanding officer of USS *Louisiana* (SSBN 743), presents Hunter Smith with a plaque from the crew during a tour of the submarine at Naval Base Kitsap - Bangor.

'Boy of the Year' Tours USS *Louisiana*

Not many 9-year-olds get an opportunity to tour an active submarine, but the Gold crew of *Ohio*-class ballistic missile submarine USS *Louisiana* (SSBN 743) provided Hunter Smith, Leukemia and Lymphoma Society's Boy of the Year, with a tour of the submarine at Naval Base Kitsap-Bangor, June 28.

Smith was diagnosed with Acute Lymphoblastic Leukemia, a cancer of the white blood cells, in 2008 at the age of two. He completed 3½ years of treatment—which included three surgeries, daily rounds of chemotherapy, and spinal taps—and he has been successfully out of treatment since 2012. In May, he was honored as the Leukemia and Lymphoma Society's Boy of the Year through a process that included a list of children who were also similarly afflicted.

Smith wants to become a Sailor when he grows up, so through the coordination of the Leukemia and Lymphoma Society's Washington/Alaska Chapter and the Navy, a tour of *Louisiana* was arranged for him.

The tour included the torpedo room, missile compartment, crew's mess, navigation and control, the crew's berthing, and the chief petty officers' quarters to get a taste of life as a Submariner.

Smith's visit concluded at the captain's stateroom where Cmdr. Melvyn Naidas, *Louisiana* Gold's commanding officer, presented him with an admiral's command ball cap, his personal challenge coin, the Chief's Quarter's coin, and a custom-made plaque from the crew of *Louisiana* Gold.

"This boy is easily the bravest person on board," said Naidas. "In his short life, he's overcome a lot, and it's tours like these that are my favorite, when we get a chance to show heroes like Hunter what it is that we do."

Welcome Home!

Machinist's Mate 1st Class Austin Shelton, from Pueblo, Colo., assigned to the *Los Angeles*-class fast-attack submarine USS *Charlotte* (SSN 766), is greeted by his daughter, Aeva, upon returning to Joint Base Pearl Harbor-Hickam following a six-month deployment to the Western Pacific.

Photo by Mass Communication Specialist 2nd Class Michael H. Lee

Qualified for Command

Lt. Mark Burchill
COMSUBDEVRON 5

Lt. Adam Carter
COMSUBRON 6

Lt. Cmdr. Joseph Campbell
COMSUBDEVRON 5

Lt. Cmdr. Michael Graham
USS *Kentucky* (SSBN 737) (B)

Lt. Robert Lee
COMSUBRON 7

Lt. Andrew McGovern
COMSUBRON 20

Lt. John Pepin
COMSUBRON 16

Lt. Beau Portillo
COMSUBRON 19

Lt. Nicklis Richarson
COMSUBRON 19

Lt. Cmdr. Nicholas Roa
COMSUBRON 19

Lt. Keith Skillin
COMSUBRON 7

Lt. Caleb Wines
COMSUBRON 20

Lt. David Yocum
COMSUBRON 5

Qualified in Submarines

Lt. Jeffrey Baluch
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Evan Boyce
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. Coy Bryant
USS *Wyoming* (SSBN 742) (B)

Lt. Sean Dickerson
USS *Alaska* (SSBN 732) (G)

Lt. j.g. Joshua Engle
USS *Alaska* (SSBN 732) (B)

Lt. j.g. Paul Graeter
USS *Georgia* (SSBN 729) (G)

Lt. j.g. William Hamilton
USS *Georgia* (SSBN 729) (G)

Lt. j.g. Ryan Hard
USS *Key West* (SSN 722)

Lt. j.g. Donald Holder
USS *Georgia* (SSGN 729) (G)

Lt. j.g. Matthew Hulst
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. Wesley Johnson
USS *Connecticut* (SSN 22)

Lt. j.g. Calvin Luzum
USS *Georgia* (SSGN 729) (G)

Lt. j.g. Thomas McBride
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Anthony Messplay
USS *Kentucky* (SSBN 737) (G)

Lt. j.g. Andrew Musselwhite
USS *Tennessee* (SSBN 734) (G)

Lt. j.g. James Schlaerth
USS *Seawolf* (SSN 21)

Lt. j.g. James Trosper
USS *Alaska* (SSBN 732) (B)

Lt. j.g. Kirk Welsh
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Nathan Whitacre
USS *Wyoming* (SSBN 742) (B)

Capt. David G. Schappert, right, relieves Capt. Jeffrey M. Grimes, left, as the commanding officer of Submarine Squadron 15 (COMSUBRON 15).
Photo by Mass Communication Specialist 3rd Class Michael Doan

Officers assigned to major commands

James A. Belz
USS *Michigan* (SSGN 727) (G)

Paul J. Bernard
Joint Base Pearl Harbor

Christopher J. Cavanaugh
COMSUBRON 11

Brien W. Dickson
NAVSTA Point Loma

Jeffrey N. Farah
USS *Frank Cable* (AS 40)

Andrew C. Hertel
NSTCP Pearl Harbor

Jack E. Houdeshell
Trident Training Facility Kings Bay

Gregory R. Kercher
USS *Georgia* (SSGN 729) (B)

Andrew J. Kimsey
USS *Ohio* (SSGN 726) (G)

Matthew A. Kosnar
Weapons Station Yorktown

Stephen G. Mack
COMSUBDEVRON 5

Roger E. Meyer
CTF 69

Nonito V. Blas
Trident Refit Facility Kings Bay

Adam D. Palmer
COMSUBRON 16

Richard E. Seif
COMSUBRON 1

Brian Sittlow
COMSUBRON 4

Bradley B. Terry
USS *Michigan* (SSGN 727) (B)

Nicholas R. Tilbrook
COMSUBRON 17

Jason D. Wartell
Naval Ordinance Test Unit

Supply Corps Qualified in Submarines

Lt. j.g. Thomas Esposito
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Ismail Tajudeen
USS *Santa Fe* (SSN 763)

Qualified Nuclear Engineering Officer

Lt. j.g. Antonio Amaya
USS *Louisville* (SSN 724)

Lt. j.g. Daniel Armstrong
USS *John Warner* (SSN 785)

Lt. Jeffrey Baluch
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Ethan Barnes
USS *Minnesota* (SSN 783)

Lt. j.g. Jason Barker
USS *Henry M. Jackson* (SSBN 730) (G)

Lt. j.g. Gary Beier
USS *Texas* (SSN 775)

Lt. j.g. Brian Bielinski
USS *Boise* (SSN 764)

Lt. j.g. Adam Carlson
USS *Santa Fe* (SSN 763)

Lt. j.g. Austin Carney
USS *Tennessee* (SSBN 734) (B)

Lt. Matthew Carr
USS *Cheyenne* (SSN 773)

Lt. j.g. Michael Cave
USS *Missouri* (SSN 780)

Lt. j.g. Jacob Cavey
USS *Olympia* (SSN 717)

Lt. j.g. Patrick Connaway
USS *Oklahoma City* (SSN 723)

Lt. j.g. Sean Cruz
USS *Providence* (SSN 719)

Lt. Bryce Downing
USS *Minnesota* (SSN 783)

Lt. j.g. Thomas Farrell
USS *Maryland* (SSBN 738) (B)

Lt. Matthew Geddings
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Mathew Hager
USS *Alexandria* (SSN 757)

Lt. j.g. Matthew Hamel
USS *Albuquerque* (SSN 706)

Lt. j.g. Logan Harris
USS *Cheyenne* (SSN 773)

Lt. j.g. Paul Heft
USS *Rhode Island* (SSBN 740) (B)

Lt. j.g. John Hennessy
USS *Kentucky* (SSBN 737) (G)

Lt. Dave Henson
USS *Cheyenne* (SSN 773)

Lt. j.g. Jordan Hester
USS *Connecticut* (SSN 22)

Lt. j.g. Trentt James
USS *Pasadena* (SSN 752)

Lt. j.g. Patric Jang
USS *Nebraska* (SSBN 739) (B)

Lt. j.g. Phillip Janssen
USS *Helena* (SSN 725)

Lt. j.g. Max Kagan
USS *Minnesota* (SSN 783)

Lt. j.g. Edwin Konrad
USS *Olympia* (SSN 717)

Lt. j.g. Jeremy Kubach
USS *New Mexico* (SSN 779)

Lt. j.g. Tyler Kuhn
USS *Montpelier* (SSN 765)

Lt. j.g. Darren Kurt
USS *Santa Fe* (SSN 763)

Lt. j.g. Elizabeth Laux
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Patrick Lear
USS *Providence* (SSN 719)

Lt. j.g. Brian Lucas
USS *Maryland* (SSBN 738) (G)

Lt. j.g. Zachary Luther
USS *San Juan* (SSN 751)

Lt. j.g. Saverio Maldari
USS *North Carolina* (SSN 777)

Lt. j.g. Thomas McBride
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Anthony Messplay
USS *Kentucky* (SSBN 737) (G)

Lt. Michael Moberg
USS *Ohio* (SSGN 726) (G)

Lt. j.g. Christopher Moreno
USS *Wyoming* (SSBN 742) (B)

Lt. j.g. Colin Okane
USS *Seawolf* (SSN 21)

Lt. Joshua Otremba
USS *Michigan* (SSGN 727) (B)

Lt. j.g. Archibald Owen
USS *Annapolis* (SSN 760)

Lt. Eowyn Pedicini
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Sean Peneyra
USS *Pasadena* (SSN 752)

Lt. j.g. Justin Piche
USS *Maine* (SSBN 741) (B)

Lt. j.g. Nicholas Raic
USS *Scranton* (SSN 756)

Lt. j.g. Stephen Ramey
USS *Tennessee* (SSBN 734) (B)

Lt. j.g. Michael Ramsdell
USS *Nevada* (SSBN 733) (G)

Lt. Alberto Ramos
USS *City of Corpus Christi* (SSN 705)

Lt. j.g. Marcus Rebersak
USS *City of Corpus Christi* (SSN 705)

Lt. j.g. Anthony Sabatino
USS *North Carolina* (SSN 777)

Lt. j.g. Christopher Saindon
USS *Alaska* (SSBN 732) (G)

Lt. j.g. Joshua Sale
USS *Hawaii* (SSN 776)

Lt. j.g. Steven Schexnider
USS *Albany* (SSN 753)

Capt. Craig R. Blakely and wife, Joni, are piped ashore during the Submarine Squadron (SUBRON) 7 change-of-command and retirement ceremony in Joint Base Pearl Harbor-Hickam. Blakely is retiring from active duty after more than 28 years of service.
Photo by Mass Communication Specialist 2nd Class Michael H. Lee

Lt. j.g. Nicholas Stiegman
USS *Louisiana* (SSBN 743) (G)

Lt. j.g. Jacob Tharp
USS *Pennsylvania* (SSBN 735) (B)

Lt. j.g. Eric Thomas
USS *Kentucky* (SSBN 737) (B)

Lt. j.g. Kirk Welsh
USS *Nevada* (SSBN 733) (B)

Lt. j.g. Fleet White
USS *Olympia* (SSN 717)

Lt. j.g. Robert Williams
USS *West Virginia* (SSBN 736) (B)

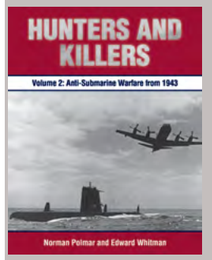
Lt. Keith Wilson
USS *North Carolina* (SSN 777)

Lt. j.g. Michael Wren
USS *Oklahoma City* (SSN 723)

Lt. j.g. Jinwoo Yoon
USS *Boise* (SSN 764)

Hunters and Killers Vol. II

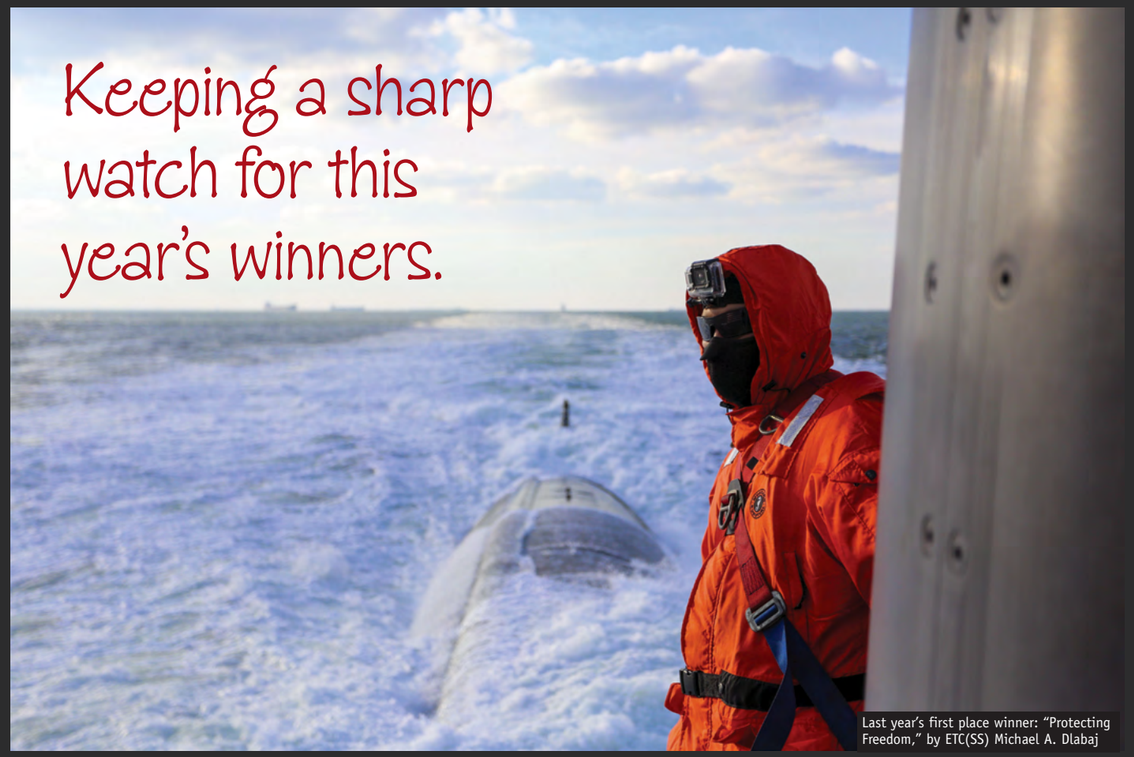
"Hunters and Killers" is a comprehensive two-volume history of all aspects of Anti-Submarine Warfare (ASW), covering its beginnings in the American Revolution through the important role of contemporary anti-submarine systems and operations. The first volume discusses ASW operations up to mid-1943, and this second volume continues from 1943 to the present. In addition to tactical and strategic narratives of major ASW campaigns, this work covers the evolution of ASW sensors, weapons, platforms, and tactics.



Volume two of "Hunters and Killers" begins at the turning point of the Battle of the Atlantic, when Allied efforts forced the U-boats to withdraw from the North Atlantic. With cryptologic breakthroughs, a growing number of escorts and long-range patrol aircraft, and new weapons and tactics, the Allied anti-submarine efforts turned the tide of battle, although the U-boat menace continued until the end of the war. In the Pacific theater, the book examines the often-overlooked ASW successes and failures that the Japanese made during World War II.

Turning to the Cold War, the authors examine the ASW developments this confrontation inspired in both the West and the Soviet Union. The superpowers developed submarines armed with nuclear weapons, and each side created weapons and sensors to counter the intensified submarine threats. The authors discuss the intensive anti-submarine aspects of the Cuban Missile Crisis and the Falklands Conflict and consider ASW developments into the early 21st century.

This second volume of "Hunters and Killers" completes the most in-depth history of ASW yet to be published. Written by Norman Polmar and Edward Whitman, two knowledgeable scholars on the subject, it is a must for anyone interested in naval history, submarines, or intelligence.



Last year's first place winner: "Protecting Freedom," by ETC(SS) Michael A. Dlabaj

ANNOUNCING:

Naval Submarine League's 18th Annual Photo Contest

UNDERSEA WARFARE Magazine is looking for this year's top submarine-related photos for the 18th Annual Photo Contest. The best of the best will be published in the Fall 2016 edition.

Established in 1999 and co-sponsored by the Naval Submarine League and the Director, Submarine Warfare (OPNAV N97), we recognize four winning photos each year with the following cash awards: 1st Place: $500, 2nd Place: $250, 3rd Place: $200 and Honorable Mention: $50.

Note: Entries must be received by September 23, 2016. However time permitting, photos received shortly after the deadline will be considered.

Digital submissions must be at least 5" by 7", at least 300 dots-per-inch (dpi) and previously unpublished in printed media. Each person is limited to five submissions, which can be sent as JPG or other digital photo format to the email address below. Printed photos may also be mailed to the following address:

Military Editor
Undersea Warfare CNO
2000 Navy Pentagon
Washington, D.C. 20350-2000

Or email to: underseawarfare@hotmail.com

Cash Prizes for the Top 4 Photos:

1st Place: $500
2nd Place: $250
3rd Place: $200
Honorable Mention: $50

USS *Razorback* (SS 394)
Little Rock, Ark.

On September 9, 1943, the keel was laid for the *Balao*-class submarine USS *Razorback* (SS 394). She was launched along with three sister ships, USS *Redfish* (SS 395), USS *Ronquil* (SS 396), and USS *Scabbardfish* (SS 397), on January 27, 1944 making this the largest single-day launch of submarines from s single shipyard in U.S. history.

During 1944 and 1945, *Razorback* completed five war patrols in the Pacific. She was part of an offensive group conducting patrols east of the Philippines in support of the mid-September 1944 landings on Palau. *Razorback* also operated with a group of submarines that patrolled in the Luzon Straits, where she damaged a freighter on December 6, 1944, and on December 30 sank the destroyer *Kuretake* and damaged another freighter. On February 1, 1945, *Razorback* set out for the East China Sea with another group and sank four wooden ships in three separate surface gun actions and captured four Japanese POWs.

In other operations, *Razorback* rescued many downed U.S. aviators.

She won five battle stars during WWII, and she is one of two surviving submarines that were present at the formal surrender of Japan at Tokyo Bay on September 2, 1945. Following WWII, *Razorback* remained active with the Pacific Fleet, participating in patrols off Japan and China. After being modified in the early 1950s to make her more modern and competitive against possible Soviet submarine threats, she provided antisubmarine training services for surface and air units off the West Coast through 1956. From 1957 to 1970, *Razorback* returned to duty in the Far East, earning her first of four Vietnam Service Medals in 1965.

On May 11, 1962, *Razorback* participated in the SWORDFISH nuclear weapons test. She was submerged at periscope depth only 2 nautical miles from the target raft when the ASROC weapon exploded.

She was decommissioned on November 30, 1970, transferred to the Turkish navy, and renamed TCG *Muratreis* (S 336) where she was involved in the 1974 Turkish invasion of the island of Cyprus.

Muratreis was decommissioned in August 2001. The city of North Little Rock bought the submarine in 2004 following the intervention of city officials and submarine veterans groups, specifically the United States Submarine Veterans, Inc. She was towed from Turkey, arriving at the Port of Little Rock on August 29, 2004.

USS *Razorback*, after a long and varied service, is now docked in North Little Rock (Pulaski County) as part of the Arkansas Inland Maritime Museum and is open for tours.